



Agenda
Utility Advisory Committee Meeting
Tuesday, September 12, 2023
Richland City Hall ~ Council Chambers
625 Swift Boulevard

Committee Members: Chair Lo Presti, Vice-Chair Larkin and Members Miller, Porter, and Staven

Council Liaisons: Council Liaison: VanDyke
Council Liaison Alternate: Jones
Staff Liaison: Whitney

Regular Meeting - 3:00 p.m.

Call to Order/Attendance:

Approval of Agenda: (Approved by Motion)

Approval of Minutes: (Approved by Motion)

1. Approval of July 11, 2023 Meeting Minutes
 - Clint Whitney, Energy Services Director

Public Comments:

Items of Business:

2. Status - Each City Utility (10 minutes)
 - Tom Huntington, Fire Chief
 - Pete Rogalsky, Public Works Director
 - Clint Whitney, Energy Services Director
3. 2023 Conservation Potential Assessment (CPA) and Demand Response Potential Assessment (DRPA) Reports (30 minutes)
 - Clint Whitney, Energy Services Director
4. Solid Waste Regional Services (45 minutes)
 - Pete Rogalsky, Public Works Director

Unfinished Business:

Other Informational Items:

5. Capital Work Plan Update - August 2023
 - Clint Whitney, Energy Services Director

Adjournment

Richland City Hall is ADA accessible. Any individual who has difficulty attending the meeting in-person may request to provide comments remotely. (Ch. 42.30 RCW) Requests for sign interpreters, audio equipment, and/or other special services must be received 48 hours prior to the meeting by calling the City Clerk's Office at 509-942-7389.



UTILITY ADVISORY COMMITTEE AGENDA ITEM COVERSHEET

Meeting Date: 9/12/2023

Agenda Category: Approval of Minutes

Prepared By: Clint Whitney, Energy Services Director

Subject:

Approval of July 11, 2023 Meeting Minutes

Department:

Energy Services

Recommended Motion:

Approve the minutes of the UAC meeting held on July 11, 2023.

Summary:

Fiscal Impact:

None.

Attachments:

I. Draft UAC Minutes 07.11.23



MINUTES

UTILITY ADVISORY COMMITTEE REGULAR MEETING
Tuesday, July 11, 2023
Richland City Hall ~ Council Chamber
625 Swift Boulevard

Utility Advisory Committee Regular Meeting – 3:00 p.m

Chair Lo Presti called the meeting to order at 3:00 pm.

Attendance: Chair Charles Lo Presti, Vice Chair Dave Larkin, Committee Members Roy Miller and Harry Staven were present. Also present was Council Liaison VanDyke, Staff Liaison and Energy Services Director Whitney, Public Works Director Rogalsky, Fire Battalion Chief (BC) Van Beek and Administrative Assistant Carpenter.

Dan Porter was excused.

Approval of Agenda

CHAIR LO PRESTI MOVED AND MEMBER STAVEN SECONDED THE MOTION TO APPROVE THE AGENDA AS PUBLISHED. THE MOTION CARRIED 4-0.

Minutes

1. Approval of the May 9, 2023 Utility Advisory Committee Regular Meeting Minutes.

MEMBER STAVEN MOVED AND MEMBER LARKIN SECONDED THE MOTION TO APPROVE THE MAY 9, 2023 MEETING MINUTES. THE MOTION CARRIED 4-0.

Public Comments

None.

Items of Business

2. Status of Each City Utility

BC Van Beek provided updates relating to the Medical Utility budget, call volumes for 2023, new staffing recruits, Fire Station 6 progress, and new ambulance acquisitions. BC Van Beek responded to questions from Members.

Director Rogalsky shared updates relating to the annual water sampling program, wastewater and stormwater capital projects, water line extensions, and solid waste landfill capping. Members inquired about chemicals within the water supply, and Mr. Rogalsky explained how chemical contaminants are being regulated.

Director Whitney presented an Electric Utility update relating to AMI electric and water meter installations and stated installations are expected to be complete in December and February, respectively. He additionally reported the high pressure sodium streetlights around the City have been replaced with LEDs, Capital Work Plan current expenditures are currently 12% of the 2023 capital budget, a new substation expansion will be located near City Shops, and the boring and conduit replacement project is taking place near the airport. There were no questions by Members.

3. Results of 2023 Electric Revenue Bond Issue

Mr. Whitney explained what elements contributed to the decision to issue revenue bonds in 2023. He stated that the Utility's bond rating was lower than the state average due to the Utility not raising rates in several years. He further stated that a rate increase is expected to be recommended in 2024.

Mr. Whitney responded to questions.

4. Net Metering Study with Washington Public Utility District Association (WPUDA)

Mr. Whitney informed Committee Members about a Net Metering Study being prepared by WPUDA, which represents several utilities within the Pacific Northwest, including City of Richland. Energy Environmental Economics (E3) will be facilitating the net metering study beginning late summer 2023, and staff anticipates providing Members the results early in 2024.

Members asked questions with staff responding.

5. PURPA I I I d Requirements to Consider Additional Demand Response (DR) and Electric Vehicle (EV) Charging Programs

Director Whitney explained what PURPA is and the recent changes to PURPA requirements relating to Utilities consideration of expanding offerings for demand response and electric vehicles. He shared what programs the Utility is currently offering and what programs would be offered soon, including thermostats that work with a demand response programs, although the Utility does not currently offer a demand-response or time-of-use program.

Members reflected on past UAC conversations relating to demand response usage. Further questions were raised about programs being offered to all customer rate classes.

Unfinished Business

None.

Other Informational Items

The following informational handouts were provided to Members:

6. Capital Work Plan Update – May 2023
7. Draft Capital Improvement Projects for 2024-2030
8. Resource Adequacy – 3rd Annual Webinar by WA Utilities and Transportation Commission and WA Department of Commerce
9. Advanced Metering Infrastructure (AMI) Status
10. Forward Planning Agenda Items

Adjournment

Chair Lo Presti adjourned the meeting at 4:30 pm.

Prepared by: _____
Jackie Carpenter, Administrative Assistant

Reviewed by: _____
Clint Whitney, Energy Services Director

Approved by: _____
Charles Lo Presti, Chair

DATE APPROVED:

DATE PUBLISHED:



UTILITY ADVISORY COMMITTEE AGENDA ITEM COVERSHEET

Meeting Date: 9/12/2023

Agenda Category: Items of Business

Prepared By: Tom Huntington, Fire Chief
Pete Rogalsky, Public Works Director
Clint Whitney, Energy Services Director

Subject:

Status - Each City Utility (10 minutes)

Department:

Energy Services

Recommended Motion:

Summary:

Fiscal Impact:

Attachments:



UTILITY ADVISORY COMMITTEE AGENDA ITEM COVERSHEET

Meeting Date: 9/12/2023

Agenda Category: Items of Business

Prepared By: Clint Whitney, Energy Services Director

Subject:

2023 Conservation Potential Assessment (CPA) and Demand Response Potential Assessment (DRPA) Reports (30 minutes)

Department:

Energy Services

Recommended Motion:

Staff recommends UAC support the revised CPA and DRPA reports for the Council's recommended adoption in 4Q23.

Summary:

The Energy Independence Act (EIA) requires electric utilities to analyze and identify energy conservation targets as specified in RCW 19.285.040. The methodology used in the 2023 Conservation Potential Assessment (CPA) is consistent with the methodology used by the Northwest Power and Conservation Council (NWPCC) in the 2021 Power Plan. The CPA estimates the cost-effective energy efficiency savings over 20 years with the EIA focus on the two and ten-year periods. The initial two years of the CPA are also the final two years of the four-year period required by the State for the City's Clean Energy Implementation Plan (CEIP). The state's Clean Energy Transformation Act (CETA), as specified in RCW 19.405, requires the CEIP for electric utility CEIP's to include the cost-effectiveness in the assessment using specific values for the social cost of carbon.

The City has been implementing energy efficiency programs since 2008. The CPA identifies the most cost-effective energy savings potential is in the commercial sector followed by the residential sector for the 2-year, 4-year, 10-year and over the 20-year period. The CPA does not identify how the energy savings will be achieved which could be through the City's own energy efficiency programs, through market transformation driven by the Northwest Energy Efficiency Alliance (NEEA), state building codes or state and federal product standards. NEEA was instrumental in bringing LED bulbs to market adoption and are currently working on heat pump water heater adoption.

Energy conservation saves energy and reduces peak demands. The projected demand reduction by energy conservation is projected to save 1.3 MW total in the 2-year period, 3.6 MW in the 4-year period, 19.7 MW in the 10-year period and 51.3 MW in the 20-year period. The total energy savings projected to save 6,538 MWh in the 2-year period, 98,102 MWh in the 10-year period and 247,287 MWh in the 20-year period. The energy costs for avoided energy over the 20-year period is levelized at \$47/MWh using 2016 dollars that is also the basis cost period in the 2021 Power Plan.

The largest projected areas for energy efficiency in the residential sector includes: HVAC (thermostats, duct sealing, weatherization, and ductless heat pumps), heat pump water heaters (HPWH), and appliances (dryer, clothes washer, refrigerator, TVs and lighting). For the commercial sector, the largest projected savings includes: lighting, various HVAC components, refrigeration, computer servers and pumps. For the industrial sector, the largest savings are with: energy management systems, lighting, refrigeration, air compressors, fans and pumps. There are minimal energy efficiency savings with the utility distribution system infrastructure compared to the other sectors.

Staff recommends UAC support the revised CPA and DRPA reports for the Council's recommended adoption in 4Q23.

Fiscal Impact:

Attachments:

1. RES 2023 CPA DRPA Presentation
2. Lighthouse Richland 2023 CPA Final Report

CITY OF RICHLAND

2023 Conservation & Demand Response Potential Assessment Results

LIGHTHOUSE ENERGY CONSULTING

Ted Light
September 12, 2023



ABOUT LIGHTHOUSE ENERGY CONSULTING



Ted Light, Principal

- Established Lighthouse Energy Consulting in 2020
- Over a decade of energy planning experience
- Formerly with EES Consulting, Energy Trust of Oregon
- Lead analyst & project manager for RES's 2019 CPA and 2021 CPA, DRPA, and CETA Compliance Work
- Part of team that reviewed 2021 Power Plan EE & DR supply curves for BPA
- Member of NW Power Council's Conservation Resource Advisory Committee

AGENDA

What is a Potential Assessment?

Background

Historic EE Targets & Achievements

CPA Results

DRPA Results

Questions

WHAT IS A POTENTIAL ASSESSMENT?

How can RES save energy/reduce demand?

Sectors

End Uses

How much is possible?

Customer Characteristics

Equipment Saturations

Past Achievements

Market Barriers

What is cost-effective?

Costs and benefits of energy efficiency & demand response

Costs and benefits of alternative resources

THREE TYPES OF POTENTIAL



BACKGROUND

Energy Independence Act

(19.285 RCW)

Development of two-year energy efficiency targets every two years

Based on Conservation Potential Assessment

Follow methodology of NW Power Council, using utility-specific inputs

Clean Energy Transformation Act

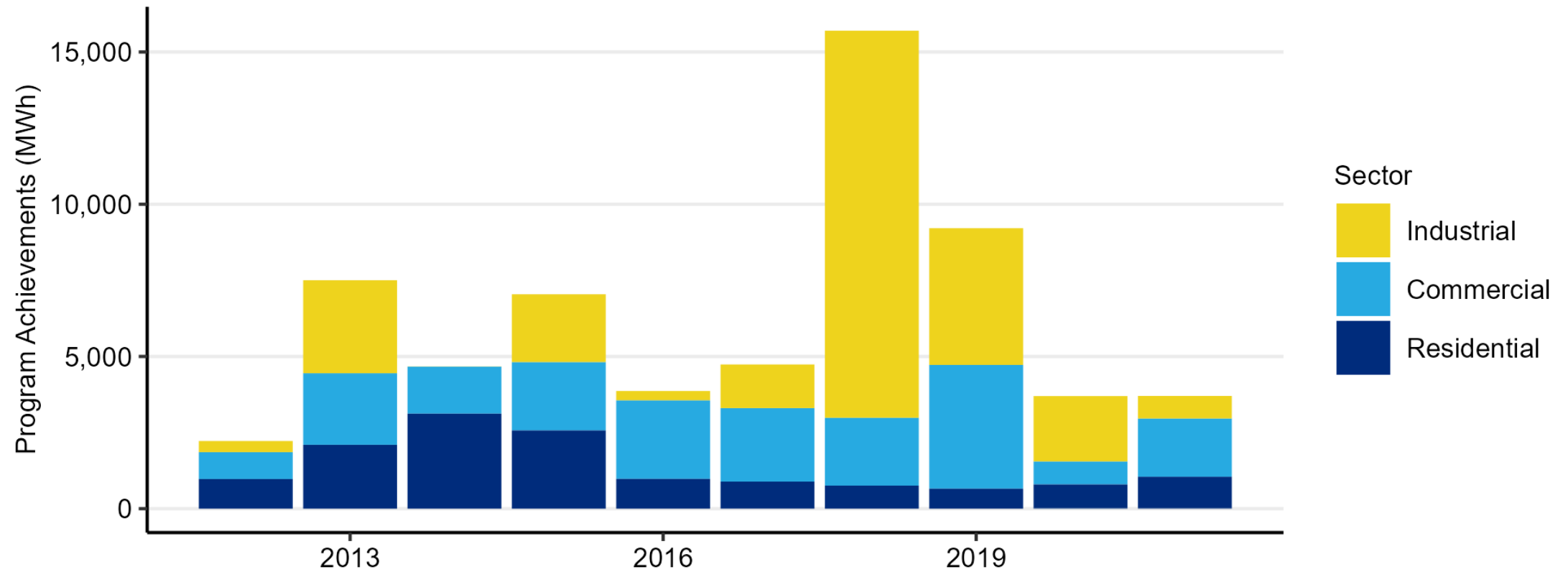
(19.405 RCW)

Four-year targets for energy efficiency & demand response in Clean Energy Implementation Plan

Based on Conservation & Demand Response Potential Assessments

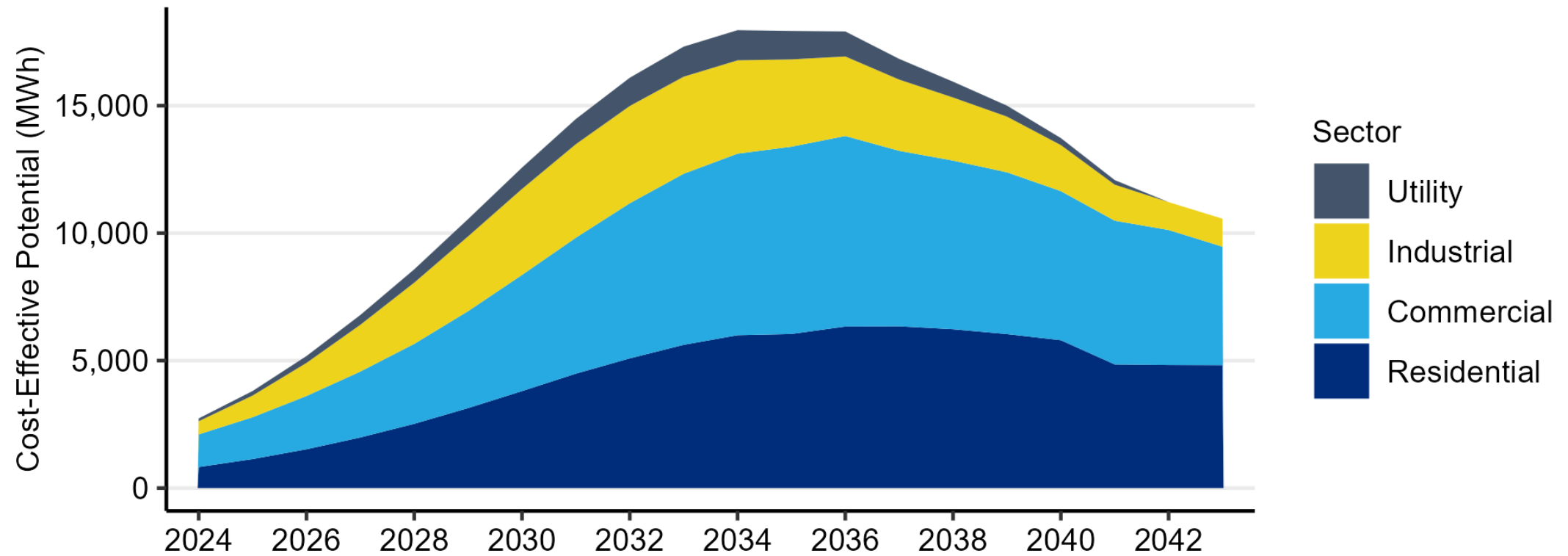
Requires utilities to use specific values for the social cost of carbon

RES CONSERVATION HISTORY



CPA RESULTS

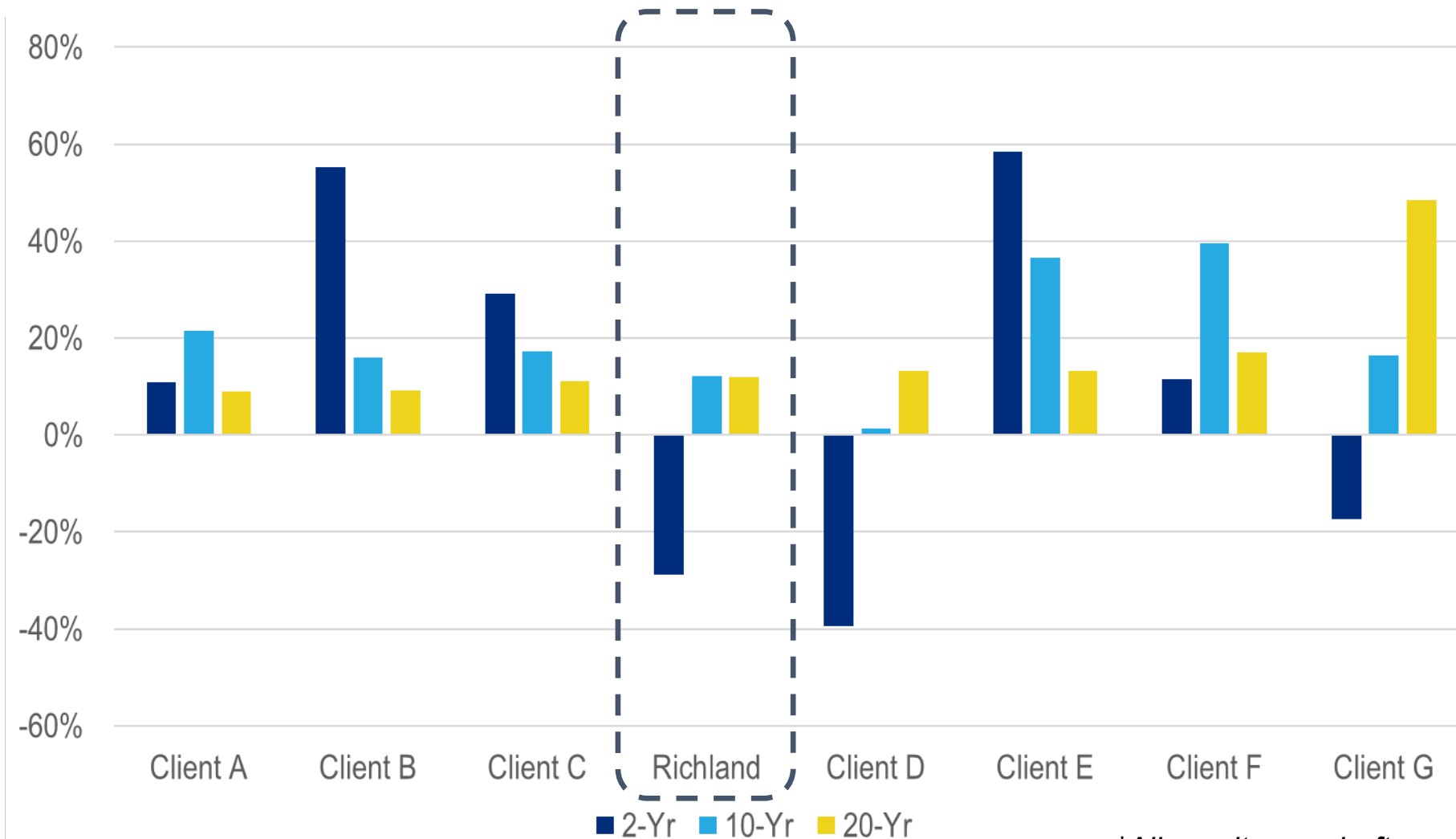
2023 CPA RESULTS



COMPARISON TO 2021 CPA

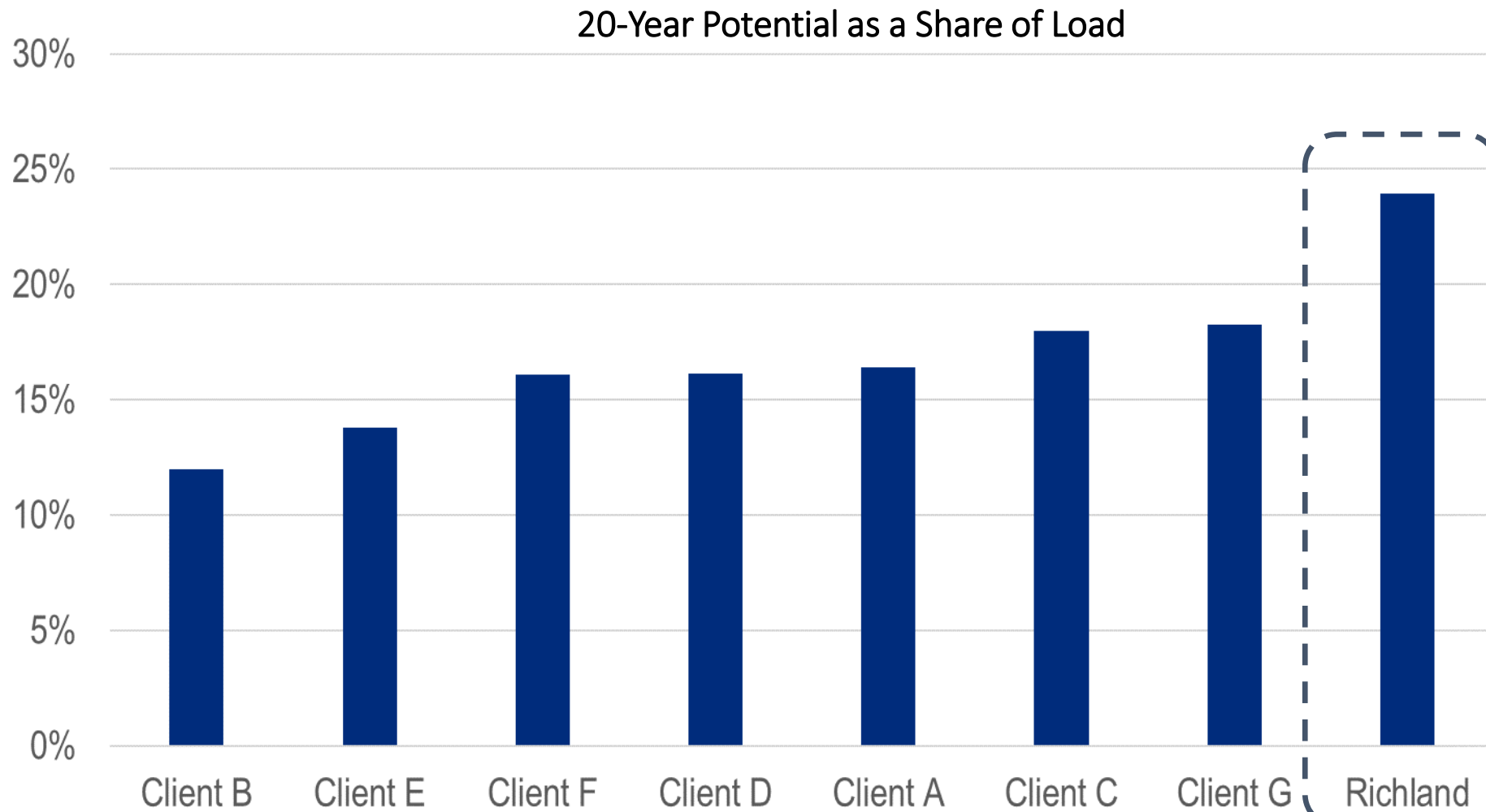
	2-Year Potential			10-Year Potential			20-Year Potential		
Sector	2021 CPA	2023 CPA	% Change	2021 CPA	2023 CPA	% Change	2021 CPA	2023 CPA	% Change
Residential	1,126	1,961	74%	22,859	30,121	32%	80,369	87,415	9%
Commercial	4,808	2,922	-39%	40,894	37,227	-9%	95,334	100,452	5%
Industrial	3,161	1,369	-57%	19,647	24,508	25%	33,273	47,582	43%
Utility	91	285	213%	4,022	6,246	55%	11,844	11,839	0%
Total	9,186	6,538	-29%	87,422	98,102	12%	220,819	247,287	12%

BENCHMARKING: CHANGE IN POTENTIAL



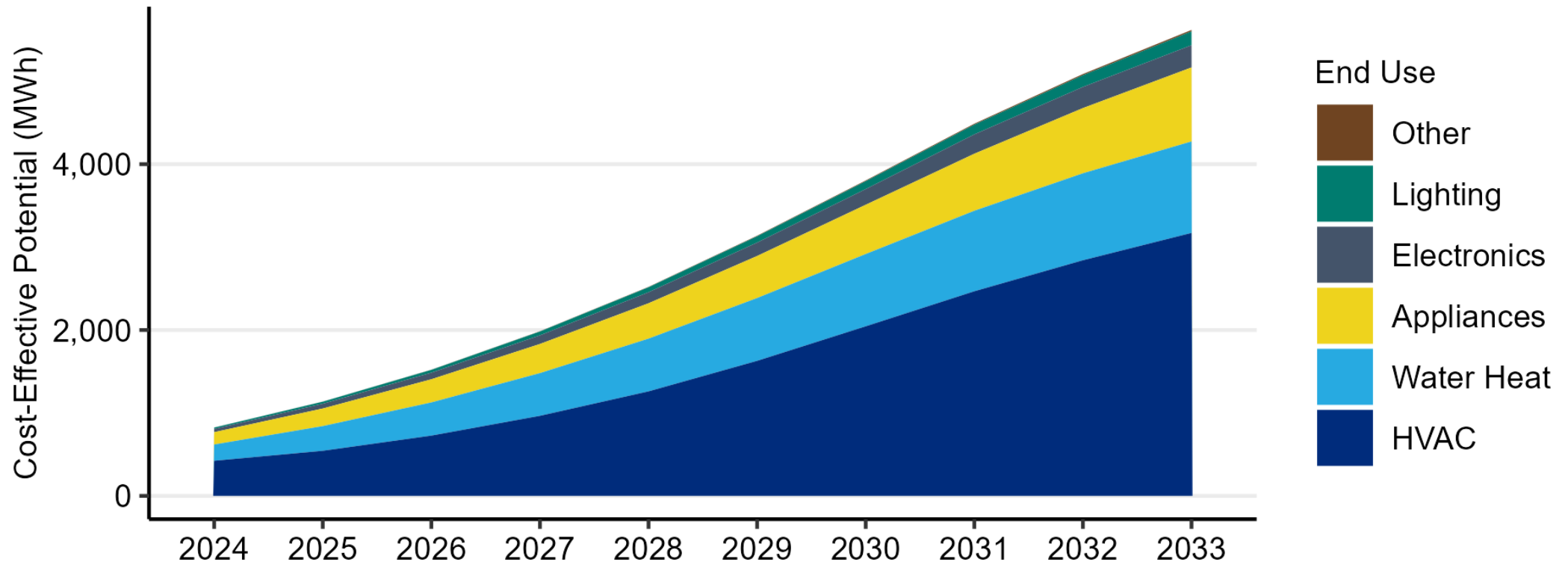
**All results are draft*

BENCHMARKING: SHARE OF LOAD

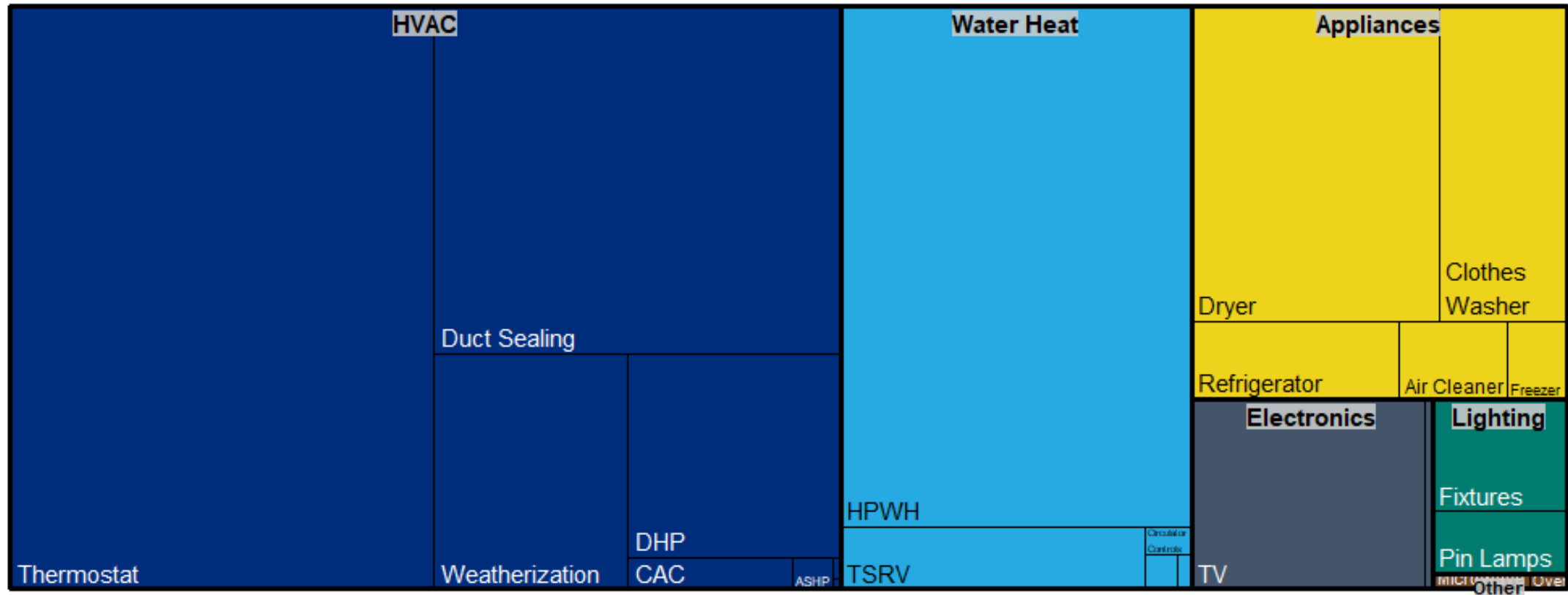


**All results are draft*

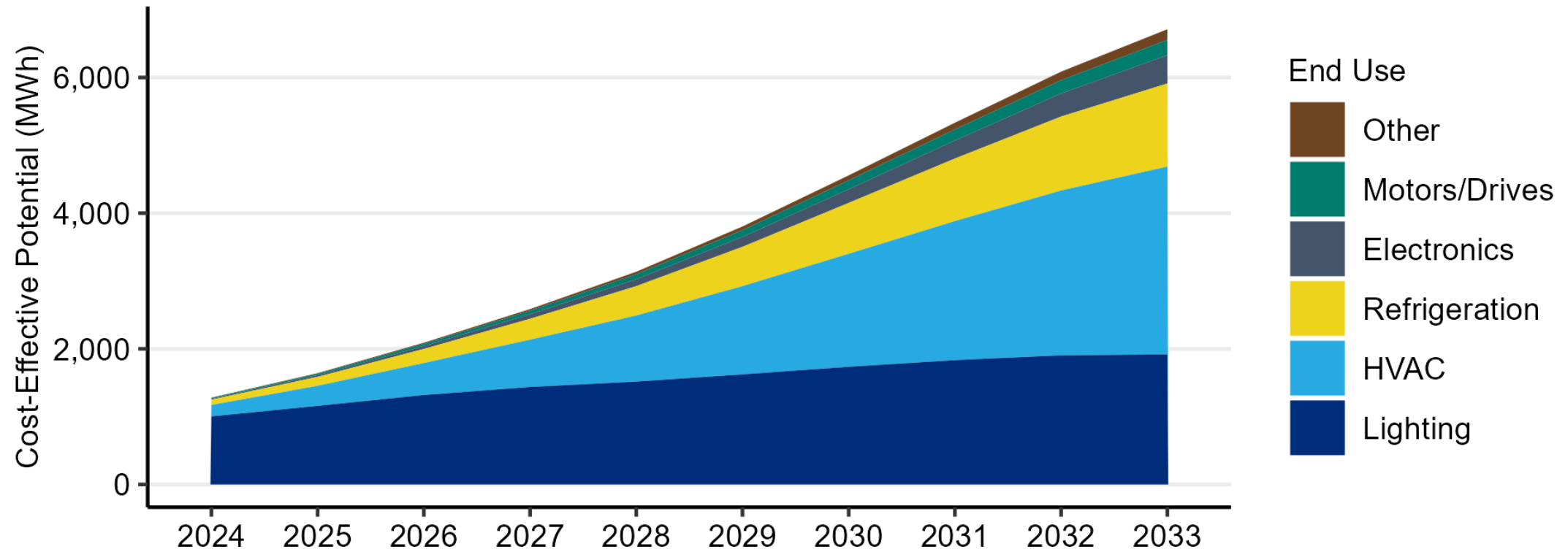
CPA RESULTS: RESIDENTIAL



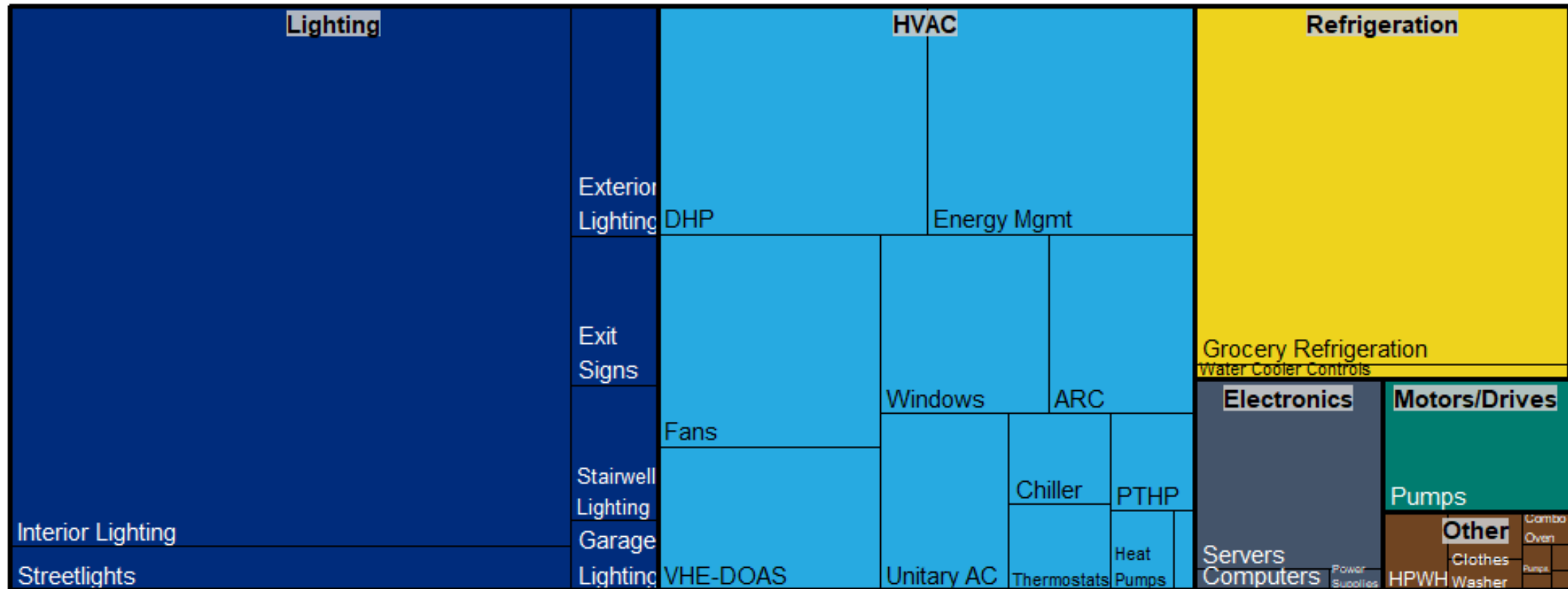
CPA RESULTS: RESIDENTIAL



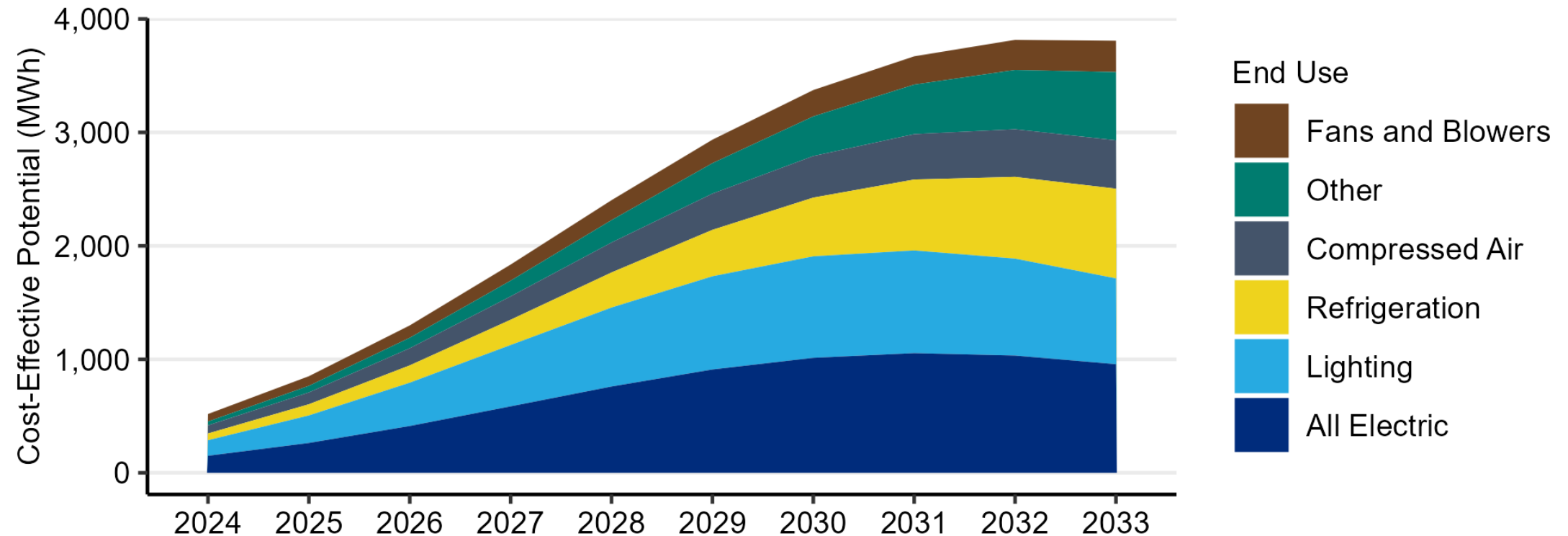
CPA RESULTS: COMMERCIAL



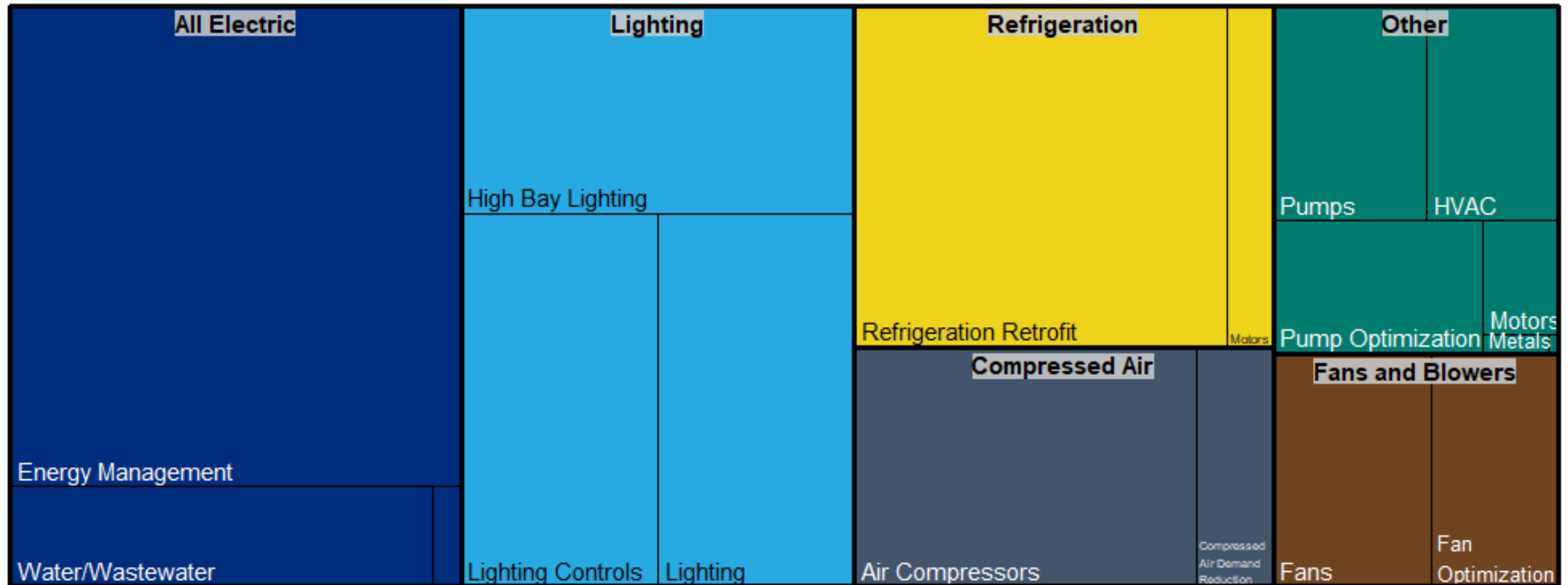
CPA RESULTS: COMMERCIAL



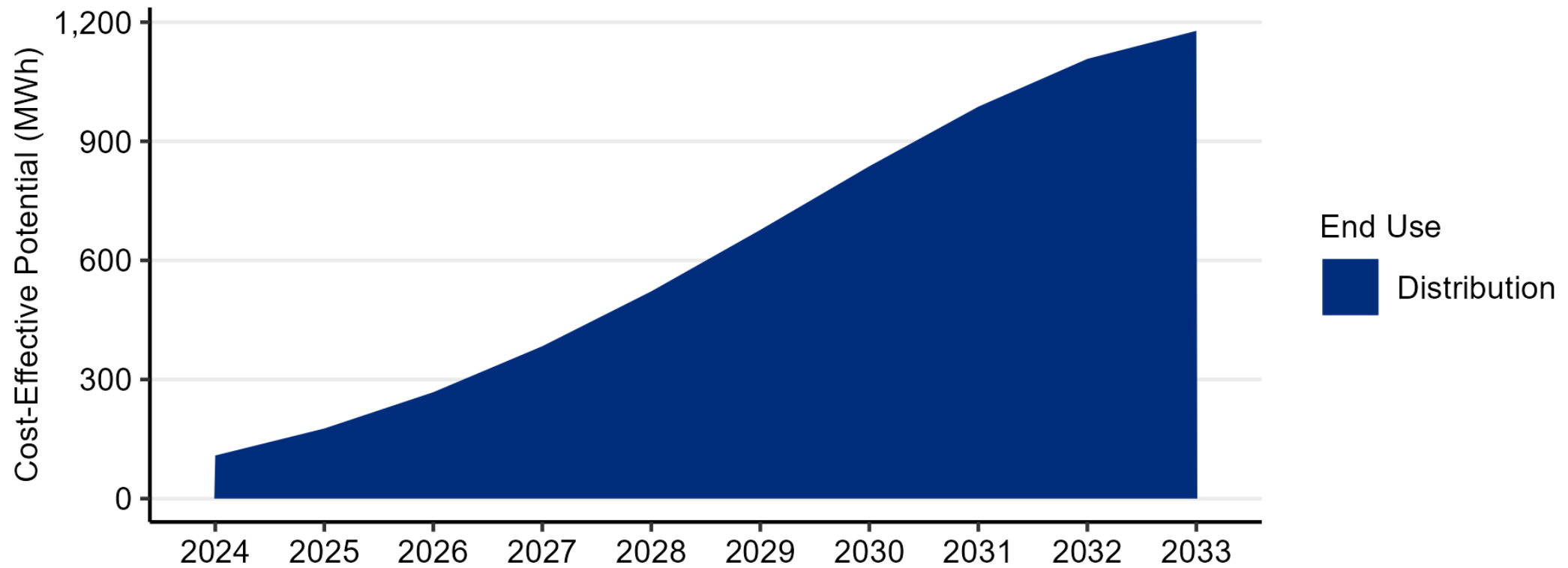
CPA RESULTS: INDUSTRIAL



CPA RESULTS: INDUSTRIAL



CPA RESULTS: UTILITY



DRPA RESULTS

DEMAND RESPONSE POTENTIAL ASSESSMENT

	Residential	Commercial	Industrial	Utility
Direct Load Control	EV Charging Grid-Enabled Water Heater Water Heater Switch Space Heating Switch Smart Thermostat	Space Heating Switch Smart Thermostat		Demand Voltage Reduction
Demand Curtailment		Demand Curtailment	Demand Curtailment	
Time-Varying Prices	Time of Use Pricing Critical Peak Pricing	Critical Peak Pricing	Critical Peak Pricing Real Time Pricing	

DRPA RESULTS

Winter

Product Name	Benefit-Cost Ratio	Cumulative MW
DVR	2.6	1.4
Res Space Heat Thermostat	1.0	3.6
Res ERWH Grid-Ready	0.8	1.6
Res Space Heat Switch	0.5	1.9
Ind Demand Curtailment	0.5	0.3
Medium Com Space Heating Switch	0.4	0.3
Res ERWH Switch	0.4	0.2
Com Demand Curtailment	0.4	0.2
Small Com Space Heating Switch	0.4	0.4
Res HPWH Grid-Ready	0.3	1.9
Res TOU Pricing	0.3	0.6
Com Space Heating Thermostat	0.3	0.3
Res EV Charging	0.2	2.5
Res HPWH Switch	0.1	0.2
Res Critical Peak Pricing	0.1	0.4
Com Critical Peak Pricing	0.1	0.3
Ind Critical Peak Pricing	0.0	0.1

Summer

Product Name	Benefit-Cost Ratio	Cumulative MW
DVR	2.5	1.0
Res Space Cooling Thermostat	1.5	3.2
Medium Com Space Cooling Switch	0.9	0.7
Res ERWH Grid-Ready	0.6	1.6
Ind Demand Curtailment	0.6	0.3
Com Space Cooling Thermostat	0.4	0.4
Com Demand Curtailment	0.4	0.2
Res TOU Pricing	0.4	0.8
Res Space Cooling Switch	0.4	0.5
Res ERWH Switch	0.2	0.1
Small Com Space Cooling Switch	0.2	0.3
Res EV Charging	0.2	2.5
Res Critical Peak Pricing	0.2	0.5
Res HPWH Grid-Ready	0.1	0.9
Com Critical Peak Pricing	0.1	0.4
Ind Critical Peak Pricing	0.1	0.3
Res HPWH Switch	0.1	0.1

SUMMARY



2-Year EE Target: 6,538 MWh



Update 2022-25 CEIP Target to 15,724 MWh



Lower recent savings in RES's commercial and industrial sector resulted in lower near-term potential



More energy savings potential in long-term due to higher market prices, customer/load growth



Recommend RES further investigate smart thermostat DR program



Thank you!



Ted Light



ted@lighthouseenergynw.com



2023 CONSERVATION POTENTIAL ASSESSMENT

Richland Energy Services

August 22, 2023

Prepared by:



LIGHTHOUSE ENERGY
— CONSULTING —

Table of Contents

Table of Contents	i
List of Figures	iii
List of Tables.....	iv
Executive Summary	1
Overview	1
Results	2
Comparison to Previous Assessment.....	4
Conclusion	5
Introduction	6
Objectives.....	6
Background	6
Study Uncertainties	6
Report Organization	7
Methodology	8
High-level Methodology	8
Economic Inputs	8
Other Financial Assumptions	10
Measure Characterization	10
Customer Characteristics	11
Energy Efficiency Potential	11
Recent Conservation Achievement	13
Overall	13
Residential	13
Commercial	14
Industrial	14
Customer Characteristics	16
Residential	16
Commercial	18
Industrial	18
Distribution System Efficiency	19
Results	20
Achievable Conservation Potential.....	20

Cost-Effective Conservation Potential	21
Sector Summary	22
Scenario Results	26
Summary	28
Compliance with State Requirements	28
References.....	29
Appendix I: Acronyms.....	30
Appendix II: Glossary	31
Appendix III: Compliance with State Requirements	32
Appendix IV: Avoided Costs.....	36
Avoided Energy Costs	36
Deferred Transmission and Distribution Capacity Costs.....	38
Deferred Generation Capacity Costs	39
Social Cost of Carbon.....	39
Renewable Portfolio Standard Compliance Costs	39
Risk Mitigation Credit	40
Northwest Power Act Credit.....	40
Summary	40
Appendix V: Measure List.....	42
Appendix VI: Energy Efficiency Potential by End Use	46
Appendix VII: Ramp Rate Alignment Documentation.....	48
Ramp Rate Adjustments.....	48
Ramp Rate Alignment Process.....	49

List of Figures

Figure 1: Historic RES Program Achievements	1
Figure 2: Cost-Effective Energy Savings Potential by Sector.....	3
Figure 3: Annual Incremental Energy Efficiency Potential.....	4
Figure 4: Annual Cumulative Energy Efficiency Potential	4
Figure 5: Conservation Potential Assessment Methodology	8
Figure 6: Avoided Energy Costs	9
Figure 7: Types of Energy Efficiency Potential	12
Figure 8: Recent Conservation Achievements by Sector	13
Figure 9: 2021-2022 Residential Program Achievements by End Use.....	14
Figure 10: 2021-2022 Commercial Program Achievements by End Use	14
Figure 11: 2021-2022 Industrial Program Achievements by End Use	15
Figure 12: 20-Year Supply Curve	20
Figure 13: 20-Year Benefit-Cost Ratio Supply Curve.....	21
Figure 14: Annual Cost-Effective Potential by Sector	21
Figure 15: Annual Residential Potential by End Use.....	22
Figure 16: Residential Potential by End Use and Measure Category.....	23
Figure 17: Annual Commercial Potential by End Use	23
Figure 18: Commercial Potential by End Use and Measure Category	24
Figure 19: Annual Industrial Potential by End Use	24
Figure 20: Industrial Potential by End Use and Measure Category	25
Figure 21: Annual Distribution System Potential	25
Figure 22: On- and Off-Peak Price Forecast.....	37
Figure 23: Comparison of On-Peak Price Scenarios.....	38
Figure 24: Comparison of Off-Peak Price Scenarios	38
Figure 25: Lost Opportunity Ramp Rate Adjustment.....	48
Figure 26: Retrofit Ramp Rate Adjustment	49

List of Tables

Table 1: Cost-Effective Energy Savings Potential by Sector (MWh).....	2
Table 2: Cost-Effective Peak Demand Savings Potential by Sector (MW).....	3
Table 3: Comparison of 2021 and 2023 CPA Cost-Effective Potential (MWh).....	5
Table 4: Service Territory Characteristics	16
Table 5: Residential Existing Home Characteristics	17
Table 6: Residential New Home Characteristics	17
Table 7: Commercial Floor Area by Segment	18
Table 8: Industrial Sector Sales by Segment.....	19
Table 9: Utility Distribution System Efficiency Assumptions	19
Table 10: Avoided Cost Assumptions by Scenario	26
Table 11: Cost Effective Potential (MWh) by Avoided Cost Scenario	27
Table 12: CPA Compliance with EIA Requirements	32
Table 13: Avoided Cost Assumptions by Scenario	41
Table 14: Residential End Uses and Measures	43
Table 15: Commercial End Uses and Measures.....	44
Table 16: Industrial End Uses and Measures.....	45
Table 17: Utility Distribution End Uses and Measures	45
Table 18: Residential Potential by End Use (MWh)	46
Table 19: Commercial Potential by End Use (MWh)	46
Table 20: Industrial Potential by End Use (MWh).....	47
Table 21: Utility Distribution System Potential by End Use (MWh).....	47
Table 22: Alignment of Residential Program History and Potential by Measure Category (MWh)	51
Table 23: Alignment of Residential Program History and Potential by End Use (MWh).....	53
Table 24: Alignment of Commercial Program History and Potential by End Use (MWh)	53
Table 25: Alignment of Industrial Program History and Potential by End Use (MWh)	54
Table 26: Alignment of Distribution System Program History and Potential by End Use (MWh).....	54

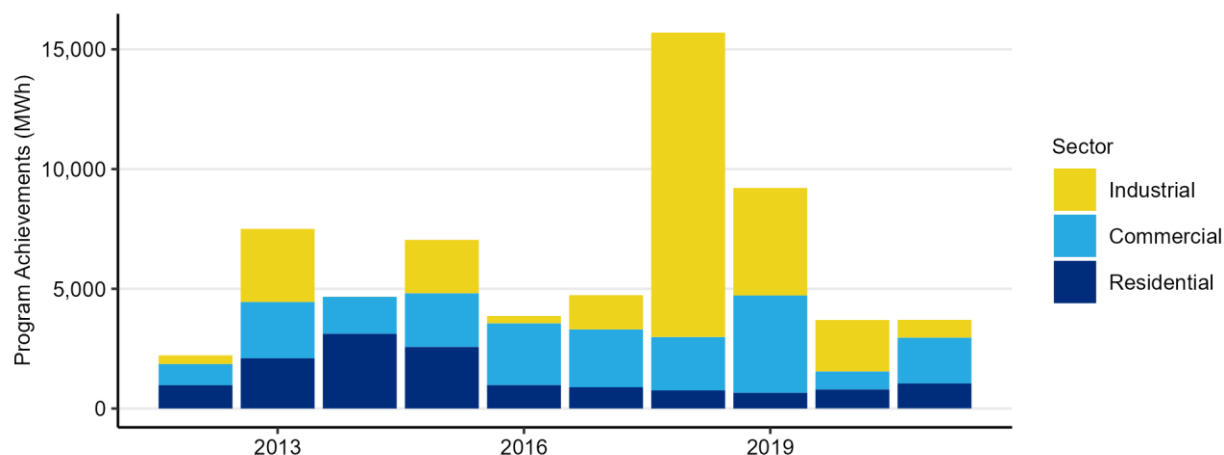
Executive Summary

Overview

This report describes the methodology and results of a conservation potential assessment (CPA) conducted by Lighthouse Energy Consulting (Lighthouse) for Richland Energy Services (RES). The CPA estimated the cost-effective energy efficiency savings potential available in RES's service territory over the 20-year period from 2024 to 2043. This report describes the results of the full 20-year period, with additional detail on the two- and 10-year periods that are the focus of Washington's Energy Independence Act (EIA). The initial two years of this study are also the final two years of the four-year period covered by RES's first Clean Energy Implementation Plan (CEIP). If desired, the results of this study can be used to update the conservation target identified in that CEIP.

RES provides electricity service to over 25,000 customers across a service territory that covers 48 square miles. The EIA requires that utilities with more than 25,000 customers identify and acquire all cost-effective energy efficiency resources and meet targets set every two years through a CPA. While RES only recently surpassed this threshold, it has been implementing energy efficiency programs since at least 2008, when the Regional Technical Forum (RTF) began tracking regional conservation achievements by utility. A summary of RES's program achievements since 2012 is shown in Figure 1, based on the Regional Technical Forum's (RTF) Regional Conservation Progress Report.

Figure 1: Historic RES Program Achievements



The EIA specifies the requirements for setting conservation targets in RCW 19.285.040 and WAC 194-37-070 Section (5), parts (a) through (d). The methodology used in this assessment complies with these requirements and is consistent with the methodology used by the Northwest Power and Conservation Council (Council) in the 2021 Power Plan. Washington's Clean Energy Transformation Act (CETA) has additional requirements for CPAs; namely, that the assessment of cost-effectiveness make use of specific values for the social cost of carbon. Appendix III details these requirements and how this assessment fulfills those requirements.

This CPA used much of the final 2021 Power Plan materials, with customizations to make the results specific to RES's service territory and customers. Notable changes in this CPA relative to RES's previous assessment include the following:

- Energy Efficiency Measures
 - This assessment uses the measures savings, costs, and other characteristics based on the measures included in the final 2021 Power Plan, with updates to dozens of measures based on new information from the RTF and additional customizations to make the measures specific to RES.
- Avoided Costs
 - A new market price forecast was incorporated, which has a 20-year levelized value of \$47/MWh (2016\$), an increase of 34% over the market prices used in RES's 2021 CPA.
- Customer Characteristics
 - Updated counts of residential homes.
 - Updated estimates of commercial floor area
 - Updated breakdowns of RES's industrial sector loads
 - Updated sector growth rates.
- Program Impacts
 - Consideration of RES's recent conservation program achievements

Results

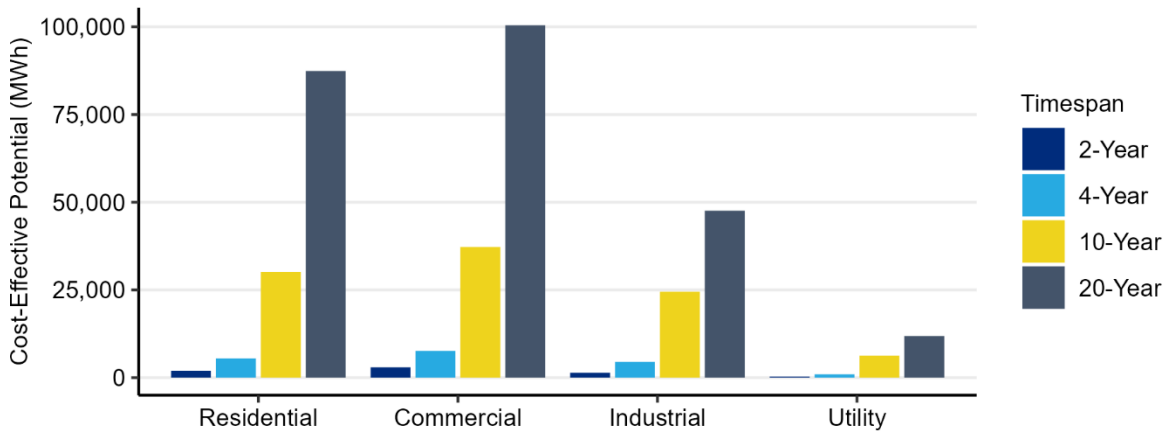
Table 1 and Figure 2 show the cost-effective energy efficiency potential by sector over two-, four-, 10-, and 20-year periods. Over the 20-year planning period, RES has over 247,000 MWh of cost-effective conservation available, which is approximately 24% of its projected 2043 load. The EIA focuses on the two- and 10-year potential, which are 6,538 MWh and 98,102 MWh, respectively.

Table 1: Cost-Effective Energy Savings Potential by Sector (MWh)

Sector	2-Year	4-Year	10-Year	20-Year
Residential	1,961	5,467	30,121	87,415
Commercial	2,922	7,598	37,227	100,452
Industrial	1,369	4,503	24,508	47,582
Utility	285	937	6,246	11,839
Total	6,538	18,506	98,102	247,287

Note: In this and all subsequent tables, totals may not match due to rounding.

Figure 2: Cost-Effective Energy Savings Potential by Sector



Over the long term, the residential and commercial sectors have the largest potential. In the near term, the industrial sector makes up 20% of the 2-year potential. A much smaller amount of potential is available in the utility sector.

This assessment does not specify how the energy efficiency potential will be achieved. Possible mechanisms include RES's own energy efficiency programs, market transformation driven by the Northwest Energy Efficiency Alliance (NEEA), state building codes, and state or federal product standards. Often, the savings associated with a measure will be acquired by several of these mechanisms over the course of its technological maturity. For example, heat pump water heaters started as one of NEEA's market transformation initiatives. Subsequently, they became a regular offering in utility programs across the Northwest and are starting to work their way into federal product standards.

Energy efficiency also contributes to reductions in peak demand. This assessment used hourly load and savings profiles developed by the Council to identify the demand savings from each measure that would occur at the time of RES's system peak. The cost-effective energy savings potential identified in this assessment will result in more than 51 MW of peak demand savings over the 20-year planning period, as shown in Table 2. This represents 24% of RES's estimated 2043 peak demand.

Table 2: Cost-Effective Peak Demand Savings Potential by Sector (MW)

Sector	2-Year	4-Year	10-Year	20-Year
Residential	0.5	1.4	8.4	25.4
Commercial	0.5	1.4	7.0	17.6
Industrial	0.2	0.6	3.3	6.6
Utility	0.0	0.1	0.9	1.7
Total	1.3	3.6	19.7	51.3

This CPA used ramp rates to reflect the share of available potential that could be acquired in each year of the study period. The ramp rates are based on those developed by the Council in the 2021 Power Plan and reflect the market and program maturity of each measure. For this CPA, Lighthouse selected ramp rates that would align the near-term potential of each measure with RES's recent program achievements and the savings from NEEA's market transformation initiatives that were estimated to occur in RES's service

territory. RES provided program achievement data for 2021 and 2022 and Lighthouse assigned appropriate ramp rates for each measure so that the future acquisition of energy efficiency was aligned with recent program history while allowing for the acquisition of all cost-effective energy efficiency over the 20-year planning period.

The estimate of annual energy efficiency potential by sector is shown in Figure 3. The available cost-effective potential starts at 2,731 MWh in 2022 and grows to a maximum of nearly 18,000 MWh in 2034. After that point, the available potential diminishes through the remaining years of the planning period.

Figure 3: Annual Incremental Energy Efficiency Potential

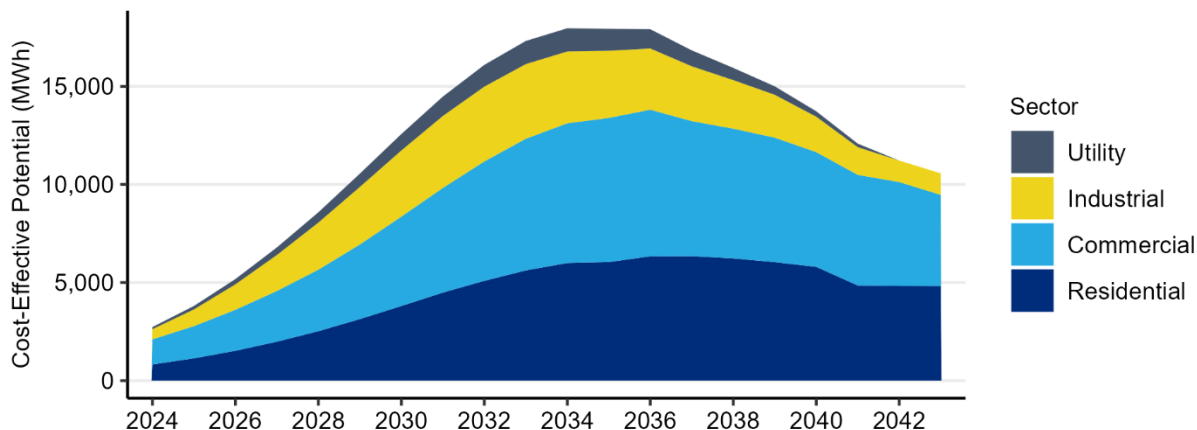
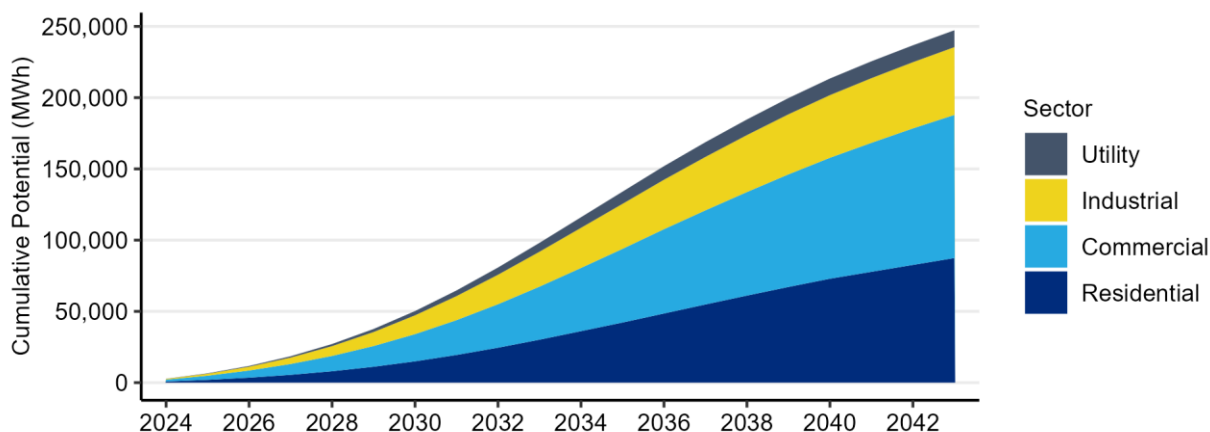


Figure 4 shows how the energy efficiency potential grows on a cumulative basis through the study period, totaling over 247,000 MWh over the 20-year planning period.

Figure 4: Annual Cumulative Energy Efficiency Potential



Comparison to Previous Assessment

Table 3 shows a comparison of the two-, 10-, and 20-year cost-effective potential by sector as quantified by the previous 2021 CPA and this 2023 CPA. The two-year comparison shows an overall reduction across all sectors. Over the long term, both the 10- and 20-year potential have increased by 12%.

Table 3: Comparison of 2021 and 2023 CPA Cost-Effective Potential (MWh)

Sector	2-Year Potential			10-Year Potential			20-Year Potential		
	2021 CPA	2023 CPA	% Change	2021 CPA	2023 CPA	% Change	2021 CPA	2023 CPA	% Change
Residential	1,126	1,961	74%	22,859	30,121	32%	80,369	87,415	9%
Commercial	4,808	2,922	-39%	40,894	37,227	-9%	95,334	100,452	5%
Industrial	3,161	1,369	-57%	19,647	24,508	25%	33,273	47,582	43%
Utility	91	285	213%	4,022	6,246	55%	11,844	11,839	0%
Total	9,186	6,538	-29%	87,422	98,102	12%	220,819	247,287	12%

Discussion of the factors leading to these changes is provided below.

Avoided Costs

As described above, the higher market prices used in this CPA have resulted in additional cost-effective potential. Some measures that were not cost-effective in the 2021 CPA are now included in the cost-effective potential identified by this CPA.

Customer Characteristics

This CPA used updated customer data for each sector.

In the commercial sector, RES provided updated load data by commercial building type. Lighthouse translated these loads to estimates of floor area with estimates of energy use intensities (EUI) from the 2019 Commercial Building Stock Assessment (CBSA). The new data resulted in an increase in the estimated floor area.

RES also provided updated loads for the industrial sector by segment. The updated values showed a significant increase in load and resulted in a corresponding increase in potential.

Conclusion

This report summarizes the CPA conducted for RES for the 2024 to 2043 timeframe. The CPA identified a lower amount of cost-effective potential in the near-term relative to the 2021 CPA, with higher amounts of potential available in the long-term.

Aligning the near-term potential to RES's recent program achievements resulted in an increase in near-term potential in the residential sector and decreases in the commercial and industrial sectors. Over the long term, updated customer characteristics and higher market prices resulted in additional potential across all three sectors.

Introduction

Objectives

This report describes the methodology and results of a CPA conducted for RES by Lighthouse. The CPA estimated the cost-effective energy savings potential available in RES's service territory over the 20-year period from 2024 to 2043. This report describes the results of the full 20-year study period, with additional details on the two- and 10-year periods that are the focus of Washington's EIA.

This assessment was conducted in a manner consistent with the requirements of Washington's RCW 19.285, and WAC 194-37. As such, this report is part of the documentation of RES's compliance with these requirements. In addition, the state of Washington's recently passed CETA includes an additional requirement for CPAs to use specific values for the social cost of carbon. The required values were used in this assessment.

The results of this CPA can be used to assist RES in planning its energy efficiency programs by identifying the amount of cost-effective energy savings available in various sectors, end uses, and measures. The results of this CPA can also be used to update the four-year energy efficiency target included in RES's CEIP. Finally, the results can be used inform RES resource planning.

Background

Washington State's EIA defines "qualifying utilities" as those with 25,000 customers or more and requires them to achieve all conservation that is cost-effective, reliable, and feasible. Since RES now serves more than 25,000 customers, it is required to comply with the EIA. The requirements of the EIA specify that all qualifying utilities complete the following by January 1 of every even-numbered year:¹

- Identify the achievable cost-effective conservation potential for the upcoming 10 years using methodologies consistent with the Council's latest power plan.
- Establish a biennial acquisition target for cost-effective conservation that is no lower than the utility's pro rata share for that two-year period of its cost-effective conservation potential for the subsequent 10 years.²

Appendix III further details how this assessment complies with each of the requirements specified for CPAs by Washington's EIA.

Study Uncertainties

There are uncertainties inherent in any long-term planning effort. While this assessment makes use of the latest forecasts of customers, loads, energy prices, and other variables, these are still subject to uncertainties and limitations, as recent global events have shown. These uncertainties include, but are not limited to:

- Customer Characteristic Data: This assessment used the best available data to reflect RES's customers. In some cases, however, the assessment relied upon data beyond RES's service territory

¹ Washington RCW 19.285.040

² In CA No. 2011-03, the State Auditor's Office has defined "pro rata" as "a proportion of an exactly calculable factor" and expects utilities to have analysis and documentation to support their identified targets, which could be more or less than 20% of the 10-year potential.

due to limitations of data availability or adequate sample sizes. There are uncertainties, therefore, related to the extent that this data is reflective of RES's customer base.

- Measure Data: Measure savings and cost estimates are based on values prepared by the Council and RTF. These estimates will vary across the region due to local climate variations and market conditions. Additionally, some measure inputs such as applicability are based on limited data or professional judgement.
- Market Price Forecasts: This assessment uses an updated market price forecast that was based on prices in March of 2023. Market prices and forecasts are continually changing.
- Utility System Assumptions: Measures in this CPA reflect cost credits based on their ability to provide transmission and distribution system capacity. The actual value of these credits is dependent on the demands on and capacity of these systems, which vary across RES's service territory. Additionally, a value for generation capacity is included, but the value of this credit is subject to the evolving need for capacity in the Northwest.
- Load and Customer Growth Forecasts: This CPA projects future customer growth based over a 20-year period. Any forecast over a similar time period will include a significant level of uncertainty.

Due to these uncertainties and the continually changing planning environment, the EIA requires qualifying utilities to update their CPAs every two years to reflect the best available data and latest market conditions.

Report Organization

The remainder of this report is organized into the following sections:

- Methodology
- Historic Conservation Achievement
- Customer Characteristics
- Results
- Scenario Results
- Summary
- References & Appendices

Methodology

This section provides an overview of the methodology used to develop the estimate of cost-effective conservation potential for RES.

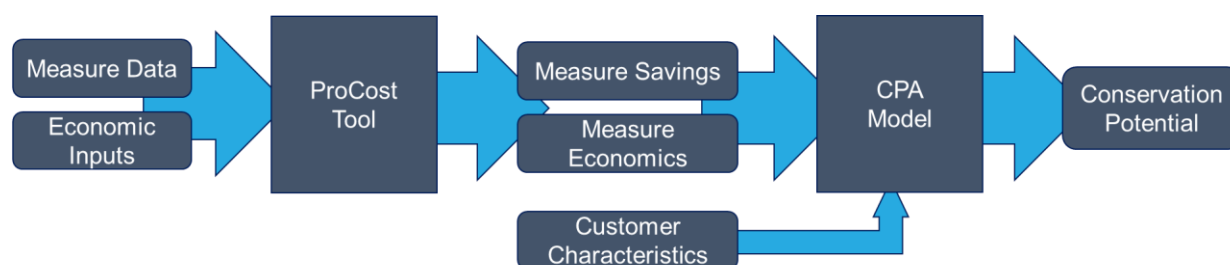
Requirements for this CPA are laid out in RCW 19.285.040 and WAC 194-37-070, Section 5 parts (a) through (d). Additional requirements are specified in the rules of Washington’s CETA. The methodology used to produce this assessment is consistent with these requirements. The development of the conservation potential follows much of the methodology used by the Council in developing its regional power plans, including the final 2021 Power Plan.

Appendix III provides a detailed breakdown of the requirements of the EIA and CETA and how this assessment complies with those standards.

High-level Methodology

The methodology used for this assessment is illustrated in Figure 5. At a high level, the process combines data on individual energy efficiency measures and economic assumptions using the Council’s ProCost tool. This tool calculates a benefit-cost ratio using the Total Resource Cost (TRC) test, which is used to determine whether a measure is cost-effective. The TRC test considers all of the costs and benefits of energy efficiency measures, regardless of who receives the benefit or pays the cost. The measure savings and economic results are combined with customer data in Lighthouse’s CPA model, which quantifies the number of remaining implementation opportunities. The savings associated with each of these opportunities are aggregated in the CPA model to determine the overall potential.

Figure 5: Conservation Potential Assessment Methodology



Economic Inputs

Lighthouse worked closely with RES staff to define the economic inputs that were used in this CPA. The inputs included avoided energy costs, carbon costs, transmission and distribution capacity costs, and generation capacity costs. Some of these are highlighted below. A full discussion of the avoided costs is included in Appendix IV.

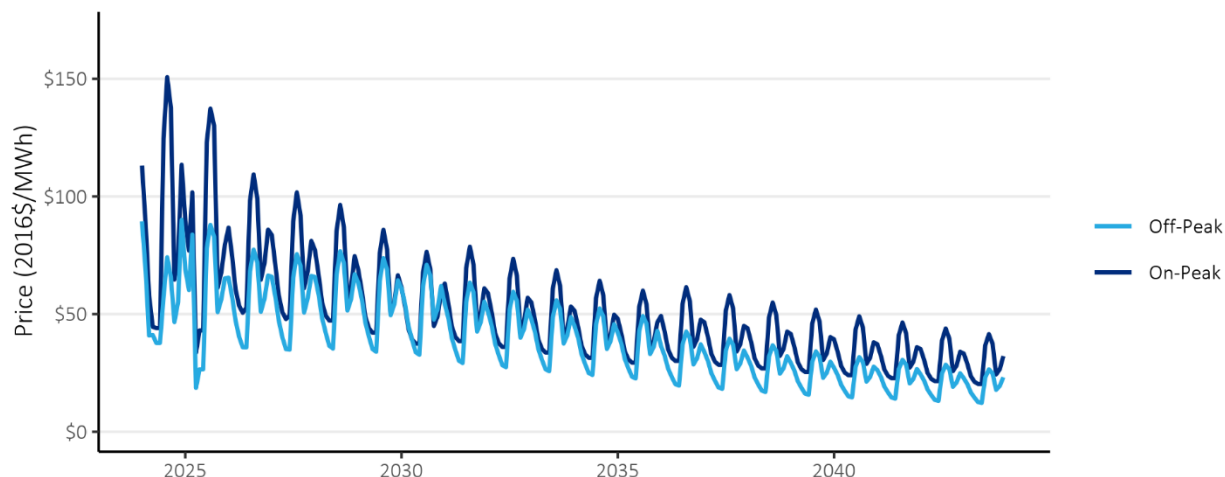
Avoided Energy Costs

Avoided energy costs represent the cost of energy purchases that are avoided through energy efficiency savings. The EIA requires utilities to “set avoided costs equal to a forecast of market prices.”³ For this CPA, Lighthouse developed a forecast of on- and off-peak market prices at the Mid-Columbia trading hub. Figure 6 below shows the market price forecast that was used for the base case scenario of this assessment. The

³ WAC 194-37-070

20-year levelized value of these prices is \$47/MWh (2016\$), a 34% increase from the price forecast used in the 2021 CPA (\$35/MWh, 2016\$). Lighthouse also created high and low variations of this forecast to be used in the avoided cost scenarios, which are described later in this report.

Figure 6: Avoided Energy Costs



Social Cost of Carbon

In addition to avoiding purchases of energy, energy efficiency measures have the potential to avoid emissions of greenhouse gases like carbon dioxide. The EIA requires that CPAs include the social cost of carbon, which the U.S. EPA defines as “a measure of the long-term damage done by a ton of carbon dioxide emissions in a given year.” It includes, among other things, changes in agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, including increases in the costs of cooling and decreases in heating costs.⁴ In addition to this requirement, Washington’s CETA requires that utilities use the social cost of carbon values developed by the Federal Interagency Workgroup using a 2.5% discount rate.⁵

Renewable Portfolio Standard Compliance Costs

By reducing RES’s overall load, energy efficiency reduces the cost of complying with Washington’s requirements for renewable and carbon-neutral energy. Beginning in 2026, RES will need fulfill the EIA requirement of sourcing 3% of its sales from renewable energy resources. With a 3% requirement for renewable energy, RES can reduce its requirement by 3 Renewable Energy Credits (RECs) by saving 100 MWh of energy. In 2030, CETA requires all sales to be greenhouse gas neutral, while allowing up to 20% of the requirement to be met through REC purchases. Based on this requirement, it is assumed that after 2030, every unit of energy savings results in an equivalent reduction in REC purchases. If RES already has sufficient RECs to meet the requirement in a given year, RECs freed up through energy efficiency can be sold.

⁴ See https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

⁵ WAC 194-40-100

Deferred Transmission and Distribution System Costs

Unlike supply-side resources, energy efficiency does not require capacity on transmission and distribution infrastructure. Instead, it frees up capacity by reducing the peak demands on these systems and can help defer future capacity expansions and the associated capital costs.

In the development of the 2021 Power Plan, the Council developed a standardized methodology for calculating these values and surveyed Northwest utilities to update the values associated with these cost deferrals. This CPA uses the values developed by the Council through that process. The resulting values are \$3.54 and \$7.82 per kW-year (in 2016 dollars) for transmission and distribution capacity, respectively.⁶ These values are applied to the demand savings coincident with the timing of the respective system peaks.

Program Administration Costs

In each of the past three power plans, the Council has assumed that program administrative costs are equal to 20% of the cost of each measure. This CPA uses that assumption, which is also consistent with RES's previous CPAs.

Risk Mitigation

Investing in energy efficiency can reduce the risks that utilities face by the fact that it is made in small increments over time, rather than the large, singular sums required for generation resources.

This CPA follows the process used in RES's previous CPAs. A scenario analysis is used to account for uncertainty, where present, in avoided cost values. The variation in inputs covers a range of possible outcomes and the amount of cost-effective energy efficiency potential is identified under each scenario. In selecting its biennial target based on this range of outcomes, RES is selecting its preferred risk strategy and the associated risk credit. This process is similar to the one used by the Council to identify the risk mitigation credit in the regional power plans.

Northwest Power Act Credit

The EIA requires that a 10% cost credit be given to energy efficiency measures. This benefit is specified in the Northwest Electric Power Planning and Conservation Act and is included by the Council in their power planning work.

Other Financial Assumptions

In addition, this assessment makes use of an assumed discount rate to convert future costs and benefits to present-year values so that values occurring in different years can be compared. This assessment uses a real discount rate of 3.75%. This is the same value that was used in RES's 2019 and 2021 CPAs and is consistent with the value used in the 2021 Power Plan. For most energy efficiency measures, the costs are incurred up front while the benefits accrue over the lifetime of the measure. A higher discount rate results in lower present values for benefits occurring in future years and generally reduces the cost effectiveness of measures.

Measure Characterization

Measure characterization is the process of defining each individual measure, including the savings, cost, lifetime, non-energy impacts, and a load or savings shape that defines when the savings occur. The Council's

⁶ These values are slightly higher than those used in the 2021 CPA and reflect updates from the Council as the 2021 Power Plan was finalized.

2021 Power Plan materials are the primary source for this information, although Lighthouse incorporated updated information from the RTF for many measures. Appendix V contains the full list of energy efficiency measures considered and sources of information used for each.

Measure savings are typically defined by a “last in” approach. With this methodology, each measure’s savings is determined as if it was the last measure installed. For example, savings from home weatherization measures are determined based on the assumption that the home’s heating system has already been upgraded. Similarly, the heating system measures are quantified based on the assumption that the home has already been weatherized. This approach is conservative but prevents overcounting savings over the long term as homes are likely to install both measures.

Measure savings also consider measure interaction. Interaction occurs when measures in one end use impact the energy use of other end uses. Examples of this include energy efficient lighting and other appliances. The efficiency of these appliances results in less wasted energy released as heat and the corresponding impacts to heating and cooling system energy demands.

These measure characteristics, along with the economic assumptions, are used as inputs to the Council’s ProCost tool. This tool determines the savings at the generator, factoring in line losses, as well as the demand savings that occur coincident with RES’s system peak. It also calculates the levelized-cost and benefit-cost ratios, which are used to determine whether measures are cost-effective.

Customer Characteristics

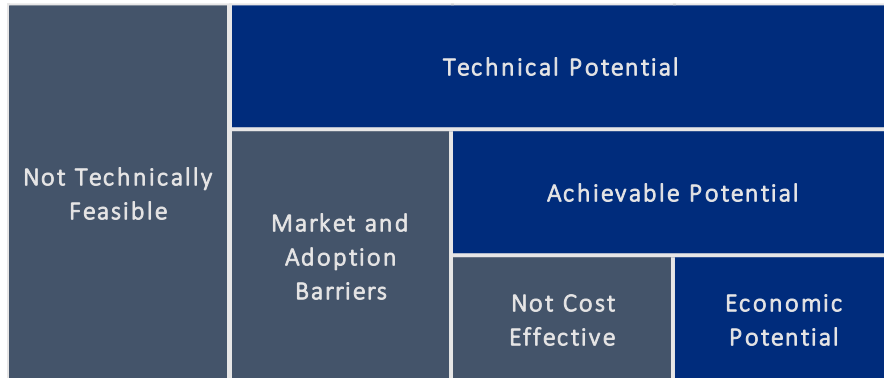
The assessment of customer characteristics is used to determine the number of available measure installation opportunities for each measure. This includes both the number of opportunities overall, as well as the share that have already been completed. The characterization of RES’s customer base was completed using data provided by RES, customer data analysis, NEEA’s commercial and residential building stock assessments, U.S. Census data, and other data sources. Details for each sector are described subsequently in this report.

This CPA used baseline measure saturation data from the Council’s 2021 Power Plan. This data was developed from NEEA’s stock assessments, market research and other studies. This data was supplemented with RES’s conservation achievements, where applicable. This achievement is discussed in the next section.

Energy Efficiency Potential

The energy efficiency measure data and customer characteristics are combined in Lighthouse’s CPA model. The model calculates the economic or cost-effective energy savings potential in calculations that progress through the three types of energy efficiency potential shown in Figure 7 below. Each type of potential is discussed in further detail below.

Figure 7: Types of Energy Efficiency Potential



First, technical potential is the theoretical maximum of energy efficiency available, regardless of cost or market constraints. It is determined by multiplying the measure savings by the number of remaining feasible installation opportunities.

The model then applies several filters that incorporate market and adoption barriers to estimate the achievable potential. These filters include assumptions about the maximum potential adoption and the pace of annual achievements. Energy efficiency planners generally assume that not all measure opportunities will be installed; some portion of the technically possible measure opportunities will remain unavailable due to unsurmountable barriers. In the Northwest, planners have historically assumed that 85% of all measure opportunities can be achieved. This assumption came from a pilot study conducted in Hood River, Oregon, where home weatherization measures were offered at no cost. The pilot was able to reach over 90% of homes and complete 85% of identified measure opportunities. In the 2021 Power Plan, the Council took a more nuanced approach to this assumption. Measures that are likely to be subject to future codes or product standards have higher maximum achievability assumptions. This CPA follows the Council's new approach.

In addition to the maximum achievability assumptions, ramp rates identify the portion of the available potential that can be acquired each year. The selection of ramp rates reflects each measure's level of program and market maturity as well as the practical constraints of what utility programs can accomplish each year.

Finally, economic, or cost-effective potential is determined by limiting the achievable potential to those measures that pass an economic screen. Per the EIA, this assessment uses the TRC test to determine economic potential. The TRC evaluates all measure costs and benefits, regardless of who pays the cost or receives the benefit. The costs and benefits include the full incremental capital cost of the measure, any operations and maintenance costs, program administrative costs, avoided energy and carbon costs, deferred capacity costs, and quantifiable non-energy impacts. Because the TRC test considers the full cost of energy efficiency measures, RES could pay up to the full cost of measures with its incentives without needing to reevaluate the cost-effectiveness of the measure, although practical constraints such as program budgets may limit this.

Recent Conservation Achievement

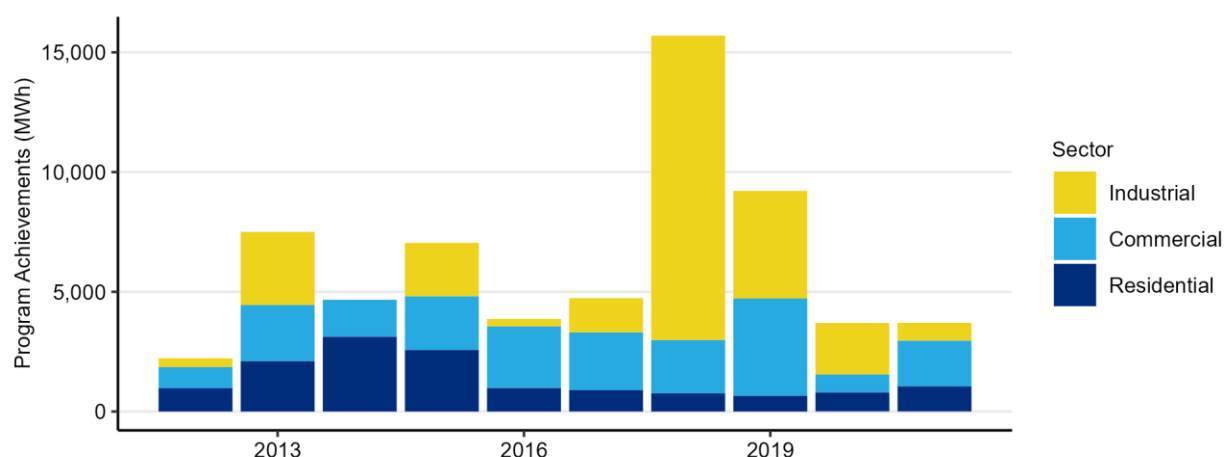
RES has a long history of energy efficiency achievement and, according to the RTF's 2021 Regional Conservation Progress Report, has averaged savings equal to 0.7% of its retail sales in each year over the 2016-2021 time period.

RES currently offers programs for its residential, commercial, and industrial customers. In addition to these programs, RES receives credit for the savings from NEEA's market transformation initiatives that happen within its service territory. In addition to this market transformation work, NEEA has helped to bring energy efficient emerging technologies, like ductless heat pumps and heat pump water heaters, to the Northwest.

Overall

Figure 8 summarizes RES's conservation achievements from 2012-2021 by sector, as reported by the RTF's 2021 Regional Conservation Progress Report.

Figure 8: Recent Conservation Achievements by Sector



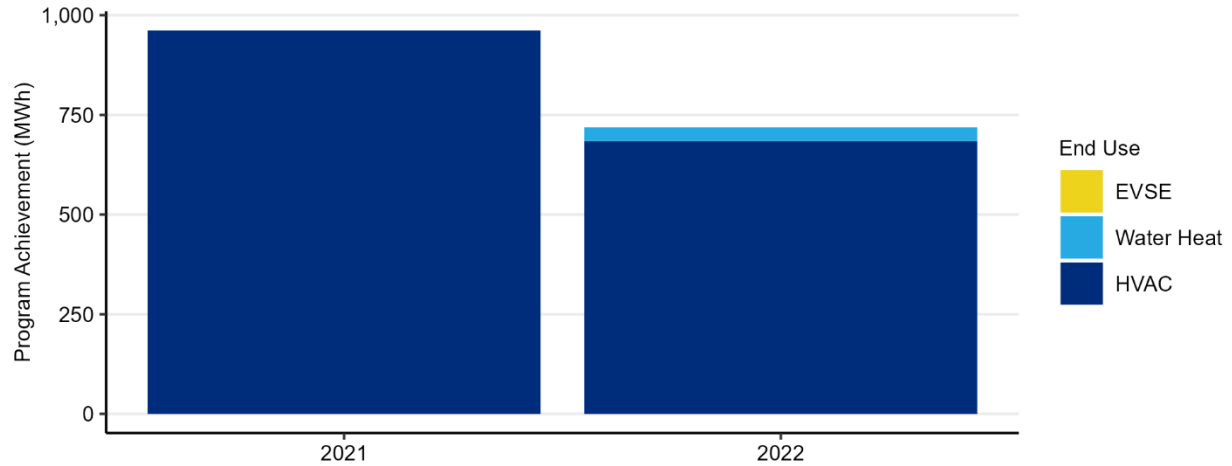
The average savings over this ten-year period is 6,236 MWh per year. Savings from NEEA's market transformation initiatives contribute additional savings that are not included in this figure. The savings from NEEA's initiatives are primarily in the residential sector.

RES provided additional details on recent savings for 2021 and 2022 for each sector, which are discussed below.

Residential

The recent residential program achievements by end use are shown in Figure 9. Most of the savings are in the HVAC end use, which includes both weatherization measures as well as heating system equipment. In 2022, RES added program offerings for heat pump water heaters and electric vehicle supply equipment (EVSE).

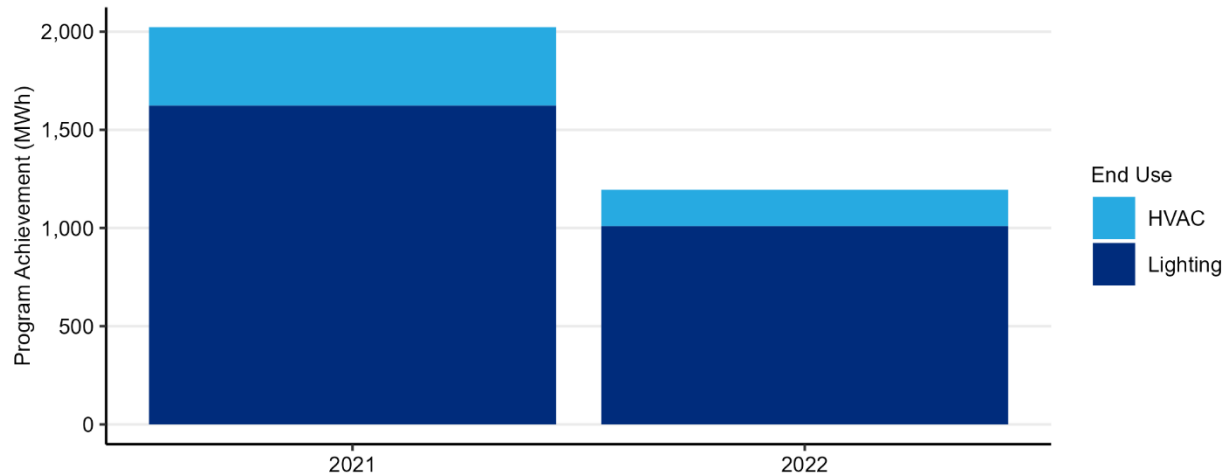
Figure 9: 2021-2022 Residential Program Achievements by End Use



Commercial

RES's commercial sector savings are primarily in the lighting end use, as shown in Figure 10. Smaller amounts of savings come from projects in the HVAC end use.

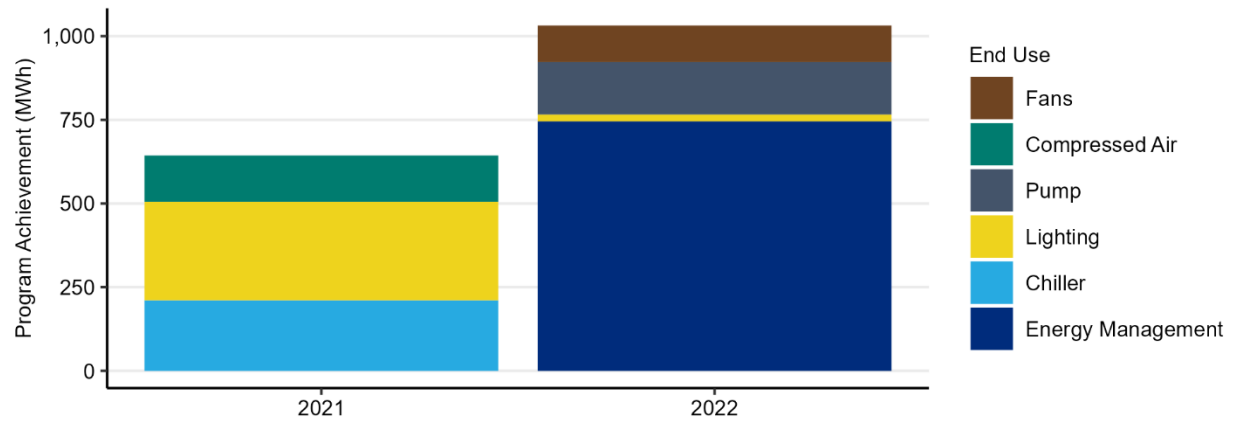
Figure 10: 2021-2022 Commercial Program Achievements by End Use



Industrial

In the industrial sector, the savings come from a variety of end uses, including energy management, chiller equipment, lighting, and other end uses. Savings from the industrial sector are often lumpy with savings varying from year to year, depending on the projects identified and chosen for capital investment by industrial facilities. These savings are summarized in Figure 11 below.

Figure 11: 2021-2022 Industrial Program Achievements by End Use



Customer Characteristics

This section describes the characterization of RES’s customer base. This process includes defining the makeup and characteristics of each individual sector. Defining the customer base determines the type and quantity of remaining opportunities to implement energy efficiency measures. Additional information about the local climate and service territory population is used to characterize some measures. This information is summarized in Table 4.

Table 4: Service Territory Characteristics

Heating Zone	Cooling Zone	Total Homes (2021)	Total Population (2021)
1	3	24,735	61,929

The count of homes is based on the number of residential customers reported to the US EIA by RES. This number is slightly lower than the value used in the 2021 CPA, but the change reflects a difference in data source. Lighthouse assumed a growth rate based on the long-term growth of residential customers over the 2013-2021 timeframe.

Lighthouse also applied a demolition rate based on assumptions for Washington State in the Council’s 2021 Power Plan. The demolition rate is used to quantify the number of existing homes that are converted to new homes through demolition or major renovation where building codes for new construction apply.

The population is based on census data for the City of Richland.

Residential

Within the residential sector, the key characteristics are the number and type of homes as well as the saturation of end use appliances such as space and water heating equipment.

Lighthouse used the same values for the distribution of home types from RES’s 2021 CPA. These were calculated based on Benton County Assessor data. Homes were classified into one of four building types: single family, manufactured homes, and low-rise multifamily apartments. According to the Benton County Assessor, no buildings were identified as high-rise multifamily dwellings and all residential buildings within the City of Richland appeared to be 3 stories or less.

To perform this classification, meters that showed minimal energy consumption (less than 1200 kWh/year in energy use) were flagged as potentially unoccupied (approximately 70 meters). Of the remaining meters, mobile homes were labelled as such using the county assessor data. Land parcels and buildings with multiple units were flagged as multifamily properties. Some meters were associated with addresses that didn’t have a match in the county assessor data. These phantom addresses belong mostly to accessory dwelling units (ADUs) or duplexes - they were geocoded using the Google Maps API to obtain the latitude and longitude, then they were matched to specific land parcels using the assessor’s GIS data.

HVAC and other appliance saturation data was based on analysis of customer usage data in combination with NEEA’s 2016 Residential Building Stock Assessment and input from RES staff. Table 5 and Table 6 summarize the characteristics that were used for this assessment for existing homes and new homes, respectively.

Table 5: Residential Existing Home Characteristics

	Single Family	Low Rise Multifamily	Manufactured
Share of Homes	68%	28%	4%
HVAC Equipment			
Electric Forced Air Furnace	7%	10%	61%
Air Source Heat Pump	52%	4%	30%
Ductless Heat Pump	2%	0%	0%
Electric Zonal/Baseboard	7%	72%	3%
Central Air Conditioning	27%	9%	42%
Room Air Conditioning	16%	64%	16%
Other Appliances			
Electric Water Heater	79%	77%	94%
Refrigerator	136%	105%	119%
Freezer	45%	16%	50%
Clothes Washer	96%	53%	100%
Electric Clothes Dryer	91%	49%	100%
Dishwasher	87%	67%	88%
Electric Oven	96%	100%	100%
Desktop	49%	40%	56%
Laptop	53%	35%	38%
Monitor	51%	44%	56%

Table 6: Residential New Home Characteristics

	Single Family	Low Rise Multifamily	Manufactured
Growth Rate	1.85%	2.31%	0.62%
HVAC Equipment			
Electric Forced Air Furnace	5%	0%	50%
Air Source Heat Pump	49%	10%	50%
Ductless Heat Pump	2%	0%	0%
Electric Zonal/Baseboard	0%	90%	0%
Central Air Conditioning	48%	10%	40%
Room Air Conditioning	0%	80%	10%
Other Appliances			
Electric Water Heater	79%	77%	94%
Refrigerator	136%	105%	119%
Freezer	45%	16%	50%
Clothes Washer	96%	53%	100%
Electric Clothes Dryer	91%	49%	100%
Dishwasher	87%	67%	88%
Electric Oven	96%	100%	100%
Desktop	49%	40%	56%
Laptop	53%	35%	38%
Monitor	51%	44%	56%

In the tables above, numbers greater than 100% imply an average of more than one appliance per home. For example, the single family refrigerator saturation of 136% means that single family homes average approximately 1.4 refrigerators per home.

Commercial

In the commercial sector, building floor area is the primary variable in determining the number of conservation opportunities, as many of the commercial measures are quantified based on the applicable amount of floor area. To estimate the commercial floor area in RES's service territory, RES provided updated loads by commercial building type. These loads were combined with energy use intensities (EUIs) from the 2019 CBSA to estimate floor area by building type. The estimated commercial floor area increased by 10 percent relative to the 2021 CPA.

Table 7 summarizes the resulting floor area estimates for each of the 18 commercial building segments.

Table 7: Commercial Floor Area by Segment

Building Type	2022 Floor Area (square feet)
Large Office	7,137,915
Medium Office	4,713,910
Small Office	4,829,210
Extra Large Retail	622,065
Large Retail	322,417
Medium Retail	1,238,355
Small Retail	1,061,638
School (K-12)	2,926,453
University	879,996
Warehouse	712,699
Supermarket	371,552
Mini Mart	55,824
Restaurant	483,601
Lodging	671,793
Hospital	526,108
Residential Care	227,541
Assembly	2,586,698
Other Commercial	1,613,442
Total	30,981,214

The commercial floor area was assigned a growth rate of 1.2% based on the growth in commercial and industrial sales reported to the EIA.

Industrial

The methodology used to estimate potential in the industrial sector is different from the residential and commercial sectors. Instead of building a bottom-up estimate of the savings associated with individual measures, potential in the industrial sector is quantified using a top-down approach that uses the annual energy consumption within individual industrial segments which is then further disaggregated into end uses. Savings for individual measures are calculated by applying the assumed savings, expressed as a percentage, to the applicable end use consumption within each industrial segment.

To quantify the industrial segment loads, RES provided 2022 energy consumption data for its industrial customers categorized by industry. The overall industrial consumption totals 226,756 MWh, as summarized

in Table 8. This represents an increase of 36% over the 2021 CPA and was driven by increased loads in the frozen food segment.

Lighthouse based the growth rate based on the compound annual growth of commercial and industrial sales reported to the EIA, which was 1.16 percent.

Table 8: Industrial Sector Sales by Segment

Segment	2020 Sales (MWh)
Water Supply	15,721
Sewage Treatment	4,303
Frozen Food	106,168
Other Food	11,321
Paper Conversion Plants	472
Chemical Manufacturing	202
Cement/Concrete Products	1,661
Primary Metal Manufacturing	24,746
Fabricated Metal Manufacturing	42,080
Misc. Manufacturing	13,459
Refrigerated Warehouse	6,624
Total	226,756

Distribution System Efficiency

The 2021 Power Plan used a new approach for quantifying the potential energy savings in measures that improve the efficiency of utility distribution systems. The Council's new approach estimated potential based on an estimate of the number of distribution substations and feeders for each utility, as well as the 2018 sales within each sector as reported to the U.S. EIA. Table 9 summarizes the assumptions used for this sector.

Table 9: Utility Distribution System Efficiency Assumptions

Characteristic	Count
Distribution Substations*	14
Residential/Commercial Substations*	12
Urban Feeders*	10
Rural Feeders*	10
2018 Residential Sales (MWh)	338,631
2018 Commercial Sales (MWh)	435,831
2018 Industrial/Other Sales (MWh)	157,422

**Note that these are estimates from the Council and may not reflect RES's actual system*

Results

This section discusses the results of the 2023 CPA. It begins with a discussion of the high-level achievable and cost-effective conservation potential and then covers the cost-effective potential within individual sectors and end uses.

Achievable Conservation Potential

The achievable conservation potential is the amount of energy efficiency that can be saved without considering the cost-effectiveness of measures. It considers market barriers and the practical limits of acquiring energy savings by efficiency programs, but not cost.

Figure 12 shows the supply curve of achievable potential over the 20-year study period. A supply curve depicts the cumulative potential against the levelized cost of energy savings, with the measures sorted in order of ascending cost. No economic screening is applied. Levelized costs are used to make the costs comparable between measures with different lifetimes as well as supply-side resources considered in utility resource planning. The costs include credits for deferred transmission and distribution system costs, avoided generation capacity, avoided periodic replacements, and non-energy impacts. With these credits, some of the lowest-cost measures have a net levelized cost that is negative, meaning that the credits exceed the measure costs.

Figure 12: 20-Year Supply Curve

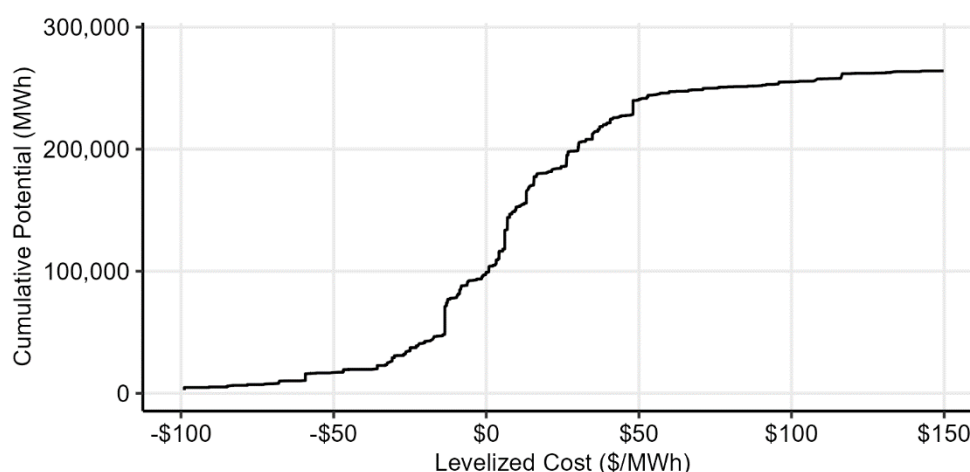


Figure 12 shows that approximately 100,000 MWh of potential are available at a cost at or below \$0/MWh. These are measures where benefits such as the deferral of capacity costs and non-energy benefits exceed the measure costs. Nearly 250,000 MWh of achievable potential is available at costs at or below approximately \$50/MWh. A total of more than 289,000 MWh is available in RES's service territory over the 20-year period, but only potential below \$150/MWh is shown in the supply curve. After approximately \$50/MWh, the supply curve flattens and any increases in potential come at increasingly higher costs.

Supply curves based on levelized cost are limited in that not all energy savings are equally valued. For example, two measures could have the same levelized cost but provide different reductions in peak demand, and therefore have different ultimate values to RES. An alternative to the supply curve based on levelized cost is one based on the benefit-cost ratio. This is shown below in Figure 13.

Figure 13: 20-Year Benefit-Cost Ratio Supply Curve

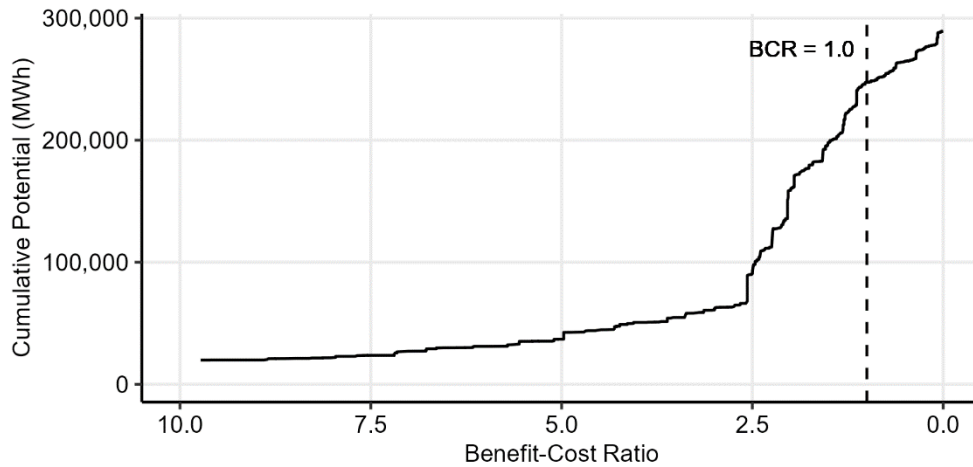


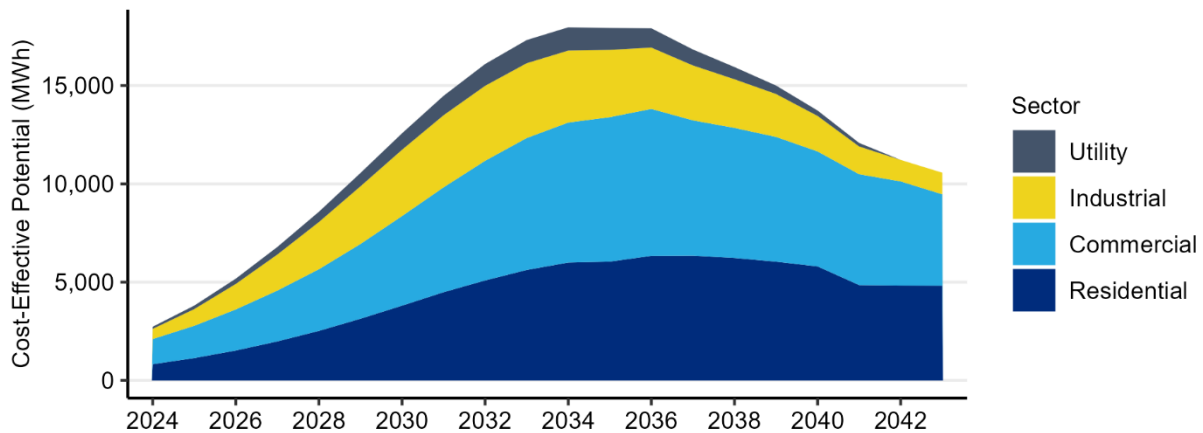
Figure 13 includes a dashed line where the benefit-cost ratio is equal to one. There are approximately 250,000 MWh of cost-effective savings potential to the left of this line, with benefit-cost ratios greater than one. This is the 20-year cost-effective potential identified earlier in this report. The slope of the line is steeper to the left of the dashed line and becomes more horizontal to the right. This suggests higher sensitivities to lower avoided costs, which would effectively shift the dashed line to the left.

The economic or cost-effective potential is described further below.

Cost-Effective Conservation Potential

Figure 14 shows the cost-effective potential by sector on an annual basis. Most of the potential is in RES's residential and commercial sectors, followed by the industrial sector, with smaller amounts available in the utility sector.

Figure 14: Annual Cost-Effective Potential by Sector



Ramp rates from the 2021 Power Plan were used to establish reasonable rates of acquisition for all sectors. Lighthouse made modifications to the assigned ramp rates for some measures to align the near-term potential with recent and expected savings in each sector. Appendix VII has more detail on the alignment of ramp rates with program expectations.

Sector Summary

The sections below describe the cost-effective potential within each sector.

Residential

Relative to RES's 2021 CPA, the cost-effective potential in the residential sector has increased notably in the near term and modestly in the long term. RES's recent program achievements, combined with NEEA's market transformation savings show that potential can be acquired more quickly than the initial two-year period of the 2021 CPA. In addition, higher market prices have increased the amount of cost-effective potential available in the long term.

Figure 15 shows the cost-effective potential by end use for the first 10 years of the study period. Measures in the HVAC (which includes both equipment and weatherization) and water heating end uses make up the largest share of potential in the sector in the near term.

The potential for these and other end uses grows during the initial 10 years of the study as the expected market share of energy efficient equipment increases.

In Figure 15, the other end use category is primarily comprised of measures in the cooking end use. The cost-effective potential in this end use is very small in the initial 10 years of the study period.

Figure 15: Annual Residential Potential by End Use

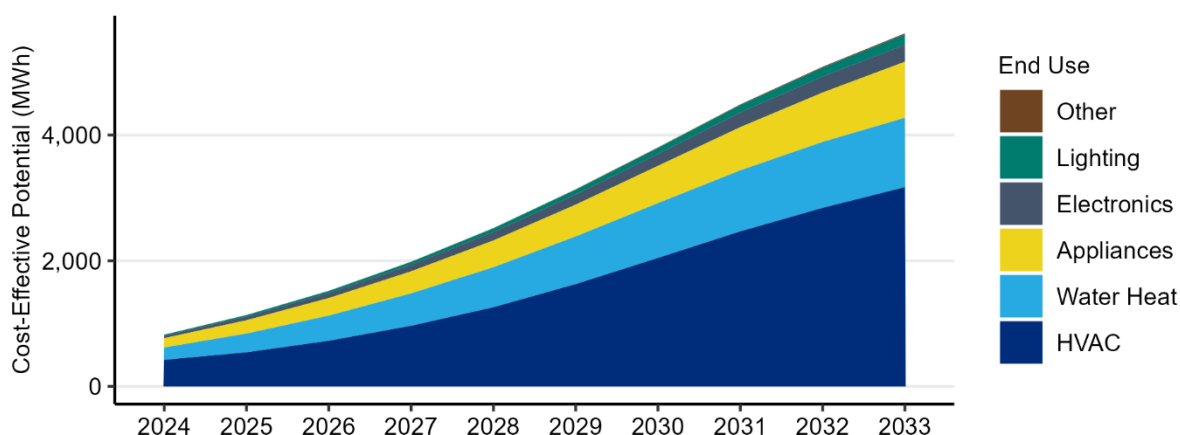
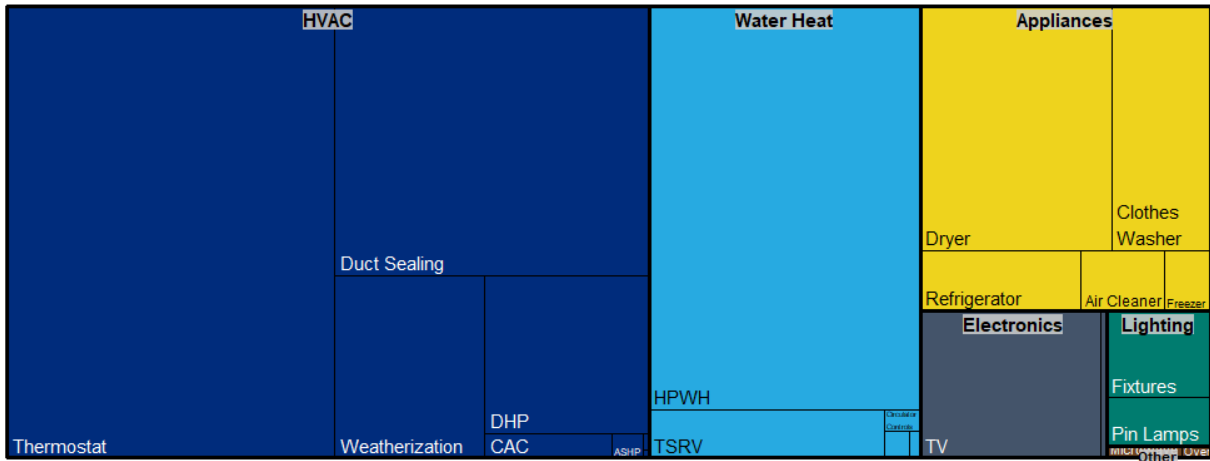


Figure 16 shows how the 10-year potential breaks down into end uses and measure categories. The area of each block represents the share of the total 10-year residential potential. Smart thermostats and duct sealing make up most of the potential in the HVAC end use, while heat pump water heaters (HPWH) and thermostatic restriction valves (TSRV) are the key measures within the water heating end use.

Note that some residential measures, such as smart thermostats and heat pump water heaters, can provide benefits as both energy efficiency and demand response resources. Any demand response benefits were not included in this CPA, although energy efficiency programs can help build a stock of flexible equipment that could be called upon by demand response programs in the future. Lighthouse assessed the demand response potential of these measures in a separate Demand Response Potential Assessment.

Figure 16: Residential Potential by End Use and Measure Category

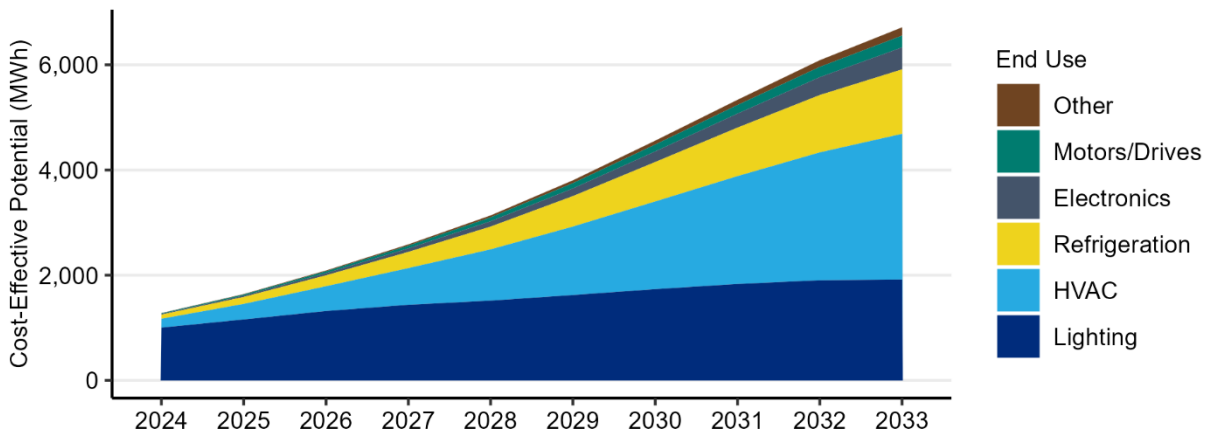


Commercial

In the commercial sector, lighting, HVAC, and refrigeration measures are the end uses with the highest potential. The lighting end use includes measures applicable to both interior and exterior lighting and remains fairly flat over the study period. The potential in other end uses grows over time, showing opportunities to pursue additional savings in these end uses.

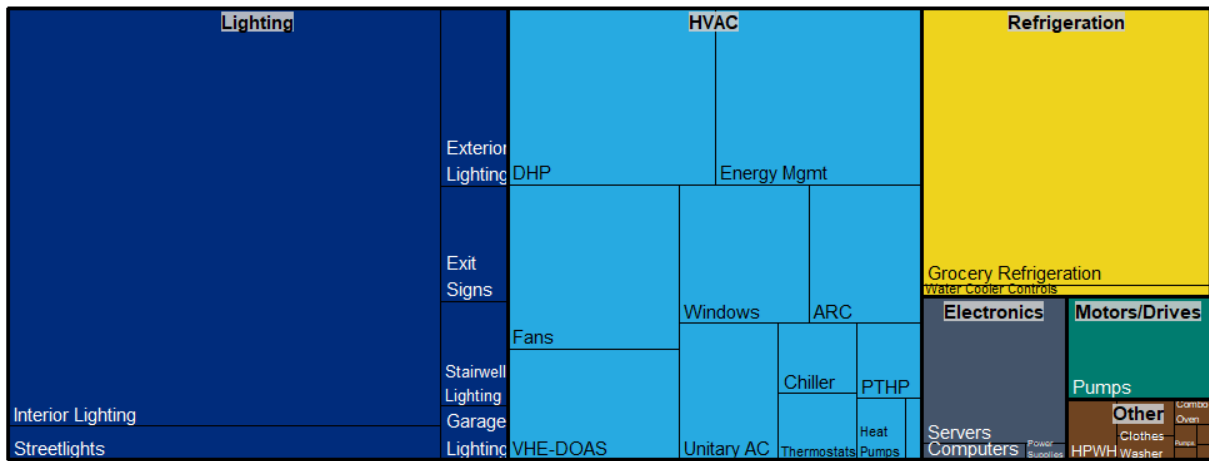
In Figure 17, the other category includes measures in the compressed air, food preparation, process loads, and water heating end uses.

Figure 17: Annual Commercial Potential by End Use



The key end uses and measure categories within the commercial sector are shown in Figure 18. The area of each block is proportional to its share of the 10-year commercial potential. Most of the potential in the lighting end use is in interior lighting, while the potential in the HVAC end use is distributed across a range of measures and equipment types. This reflects the variety of building types and HVAC system types found in the sector.

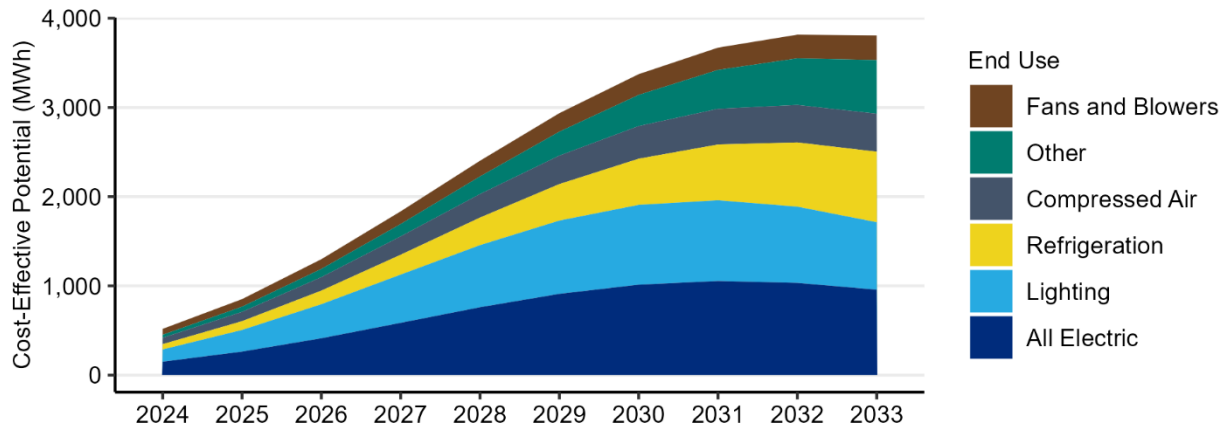
Figure 18: Commercial Potential by End Use and Measure Category



Industrial

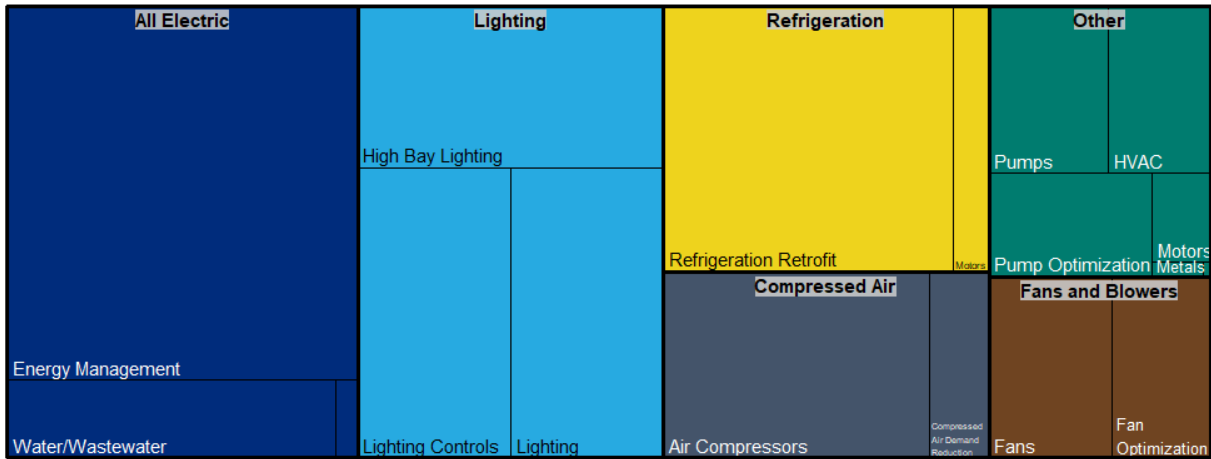
The annual industrial sector potential is shown in Figure 19. Significant amounts of potential are spread across the all electric and lighting end uses. The all electric end use includes measures applicable to all end uses, such as strategic energy management programs. Smaller amounts of potential are available through measures in the refrigeration, compressed air, and other end uses. The other category in Figure 19 includes a variety of end uses, including material handling and processing, HVAC, pump systems, and several other smaller end uses.

Figure 19: Annual Industrial Potential by End Use



The breakdown of 10-year industrial potential into end uses and measure categories is shown in Figure 20.

Figure 20: Industrial Potential by End Use and Measure Category

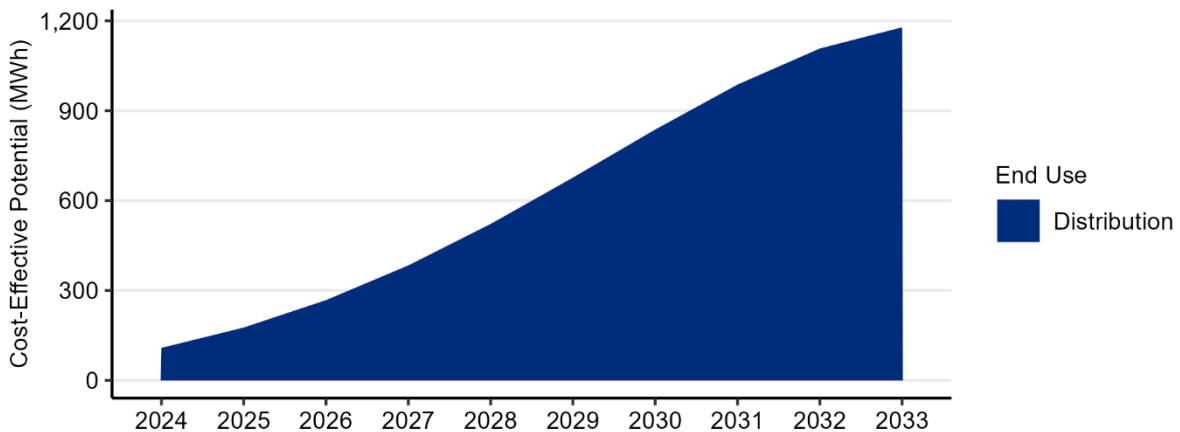


Utility

Measures in the utility sector involve the regulation of voltage to improve the efficiency of the utility distribution system. This analysis includes the measures characterized for the 2021 Power Plan, which are based on an estimate of the number of distribution substations and feeders for RES.

The annual distribution system potential is shown in Figure 21. The Council characterized three measures in the 2021 Power Plan, which use increasingly sophisticated control systems. Note that the scale for this figure has changed relative to the figures above, as the potential in this sector is much smaller than those sectors.

Figure 21: Annual Distribution System Potential



Scenario Results

This section discusses the results of two additional scenarios that were considered in addition to the base case scenario covered in the previous section. These scenarios feature low and high variations in the avoided costs values in order to understand the range of possible outcomes due to the uncertainty of these values. These scenarios allow RES to understand the sensitivity of the cost-effective potential to variations in avoided cost. All other inputs were held constant.

Table 10 summarizes the avoided cost assumptions used in each scenario, which are discussed further in Appendix IV.

Table 10: Avoided Cost Assumptions by Scenario

		Low Scenario	Base Scenario	High Scenario
Energy Values	Avoided Energy Costs (20-Year Levelized Price, 2016\$)	Market Forecast minus 20%-80% (\$25)	Market Forecast (\$47)	Market Forecast plus 20%-80% (\$70)
	Social Cost CO₂	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
	RPS Compliance	WA EIA & CETA Requirements	WA EIA & CETA Requirements	WA EIA & CETA Requirements
Capacity Values	Distribution Capacity (2016\$)	\$7.82/kW-year	\$7.82/kW-year	\$7.82/kW-year
	Transmission Capacity (2016\$)	\$3.54/kW-year	\$3.54/kW-year	\$3.54/kW-year
	Generation Capacity (2016\$)	\$69/kW-year	\$79/kW-year	\$123/kW-year
	Implied Risk Adder (Difference from Base) (2016\$)	-\$22/MWh -\$10/kW-year	N/A	\$23/MWh \$44/kW-year
	NW Power Act Credit	10%	10%	10%

Instead of using a single risk adder applied to each unit of energy, the two alternate scenarios consider potential futures with higher and lower values for the avoided cost inputs where some degree of uncertainty exists, including variations in the value of both energy and capacity. The implied risk adder row calculates the implied risk adders for the low and high scenarios by totaling the differences in both energy and capacity-based values relative to the base scenario. Further discussion of these values is provided in Appendix IV.

Table 11 summarizes the cost-effective potential across each avoided cost scenario. As discussed above, the results show higher sensitivities to the low avoided cost scenario.

Table 11: Cost Effective Potential (MWh) by Avoided Cost Scenario

Scenario	2-Year	4-Year	10-Year	20-Year
Low Scenario	5,534	15,634	82,655	202,561
Base Case	6,538	18,506	98,102	247,287
High Scenario	6,808	19,184	100,852	254,927

Overall, energy efficiency remains a low-risk resource for RES since it is purchased in small increments over time, making it unlikely that significant amounts of the resource be acquired that were over-valued.

Summary

This report has summarized the results of the 2023 CPA conducted for RES. The assessment provided estimates of the cost-effective energy savings potential for the 20-year period beginning in 2024, with details on the first ten years per the requirements of Washington State's EIA. The assessment considered a wide range of measures that are reliable and available during the study period.

Compared to RES's 2021 CPA, the potential has decreased in the near term but increased in the long term. Lighthouse aligned the near-term potential with RES's recent program achievements, which resulted in decreases in near-term potential in the commercial and industrial sectors and an increase in the residential sector.

In the longer term, increases in commercial floor space and industrial loads combined with higher market prices resulted in an increase in potential available over the 10- and 20- year time periods.

Compliance with State Requirements

The methodology used to estimate the cost-effective energy efficiency potential described in this report is consistent with the methodology used by the Council to determine the potential and cost-effectiveness of conservation resources in the 2021 Power Plan. Appendix III provides a list of Washington's EIA requirements for CPAs and a description of how each was implemented in this assessment. In addition to using a methodology consistent with the Council's 2021 Power Plan, this assessment used assumptions from the 2021 Power Plan where utility-specific inputs were not used. Utility-specific inputs covering customer characteristics, previous conservation achievements, and economic inputs were used. The assessment included the measures considered in the 2021 Power Plan materials, with additional RTF updates made available since its publication.

References

- Cadmus Group. 2018. Residential Building Stock Assessment II: Single family Homes Report 2016-17. Portland, OR: Northwest Energy Efficiency Alliance.
- Cadmus Group. 2018. Residential Building Stock Assessment II: Multifamily Buildings Report 2016-17. Portland, OR: Northwest Energy Efficiency Alliance.
- Cadmus Group. 2018. Residential Building Stock Assessment II: Manufactured Homes Report 2016-17. Portland, OR: Northwest Energy Efficiency Alliance.
- Cadmus Group. 2020. Commercial Building Stock Assessment 4 (2019) Final Report. Portland, OR: Northwest Energy Efficiency Alliance.
- Northwest Power and Conservation Council. 2021 Power Plan Technical Information and Data. December 11, 2020. Retrieved from: <https://www.nwcouncil.org/2021-power-plan-technical-information-and-data>
- Washington State Energy Code, Wash. (2018)
- Washington State Legislature. RCW 19.285.040 Energy conservation and renewable energy targets. Retrieved from: <http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.040>
- Washington State Legislature. RCW 19.260 Appliance Energy Efficiency Standards. Retrieved from: <https://app.leg.wa.gov/bills/summary?BillNumber=1444&Year=2019>

Appendix I: Acronyms

aMW	Average Megawatt
BPA	Bonneville Power Administration
CEIP	Clean Energy Implementation Plan
CETA	Clean Energy Transformation Act
CPA	Conservation Potential Assessment
EIA	Energy Independence Act
EUI	Energy Use Intensity
HPWH	Heat Pump Water Heater
HVAC	Heating, Ventilation, and Air Conditioning
IRP	Integrated Resource Plan
kW	kilowatt
kWh	kilowatt-hour
LED	Light-Emitting Diode
MW	Megawatt
MWh	Megawatt-hour
NEEA	Northwest Energy Efficiency Alliance
O&M	Operations and Maintenance
RPS	Renewable Portfolio Standard
RTF	Regional Technical Forum
SEM	Strategic Energy Management
TRC	Total Resource Cost

Appendix II: Glossary

<i>Achievable Technical Potential</i>	Conservation potential that includes considerations of market barriers and programmatic constraints, but not cost effectiveness. This is a subset of technical potential.
<i>Average Megawatt (aMW)</i>	An average hourly usage of electricity, measured in megawatts, across the hours of a day, month, or year.
<i>Avoided Cost</i>	The costs avoided through the acquisition of energy efficiency.
<i>Cost Effective</i>	A measure is described as cost effective when the present value of its benefits exceeds the present value of its costs.
<i>Economic Potential</i>	Conservation potential that passes a cost-effectiveness test. This is a subset of achievable potential. Per the EIA, a Total Resource Cost (TRC) test is used.
<i>Levelized Cost</i>	A measure of costs when they are spread over the life of the measure, like a car payment. Levelized costs enable the comparison of resources with different useful lifetimes.
<i>Megawatt (MW)</i>	A unity of demand equal to 1,000 kilowatts (kW).
<i>Renewable Portfolio Standard</i>	A requirement that a certain percentage of a utility's portfolio come from renewable resources. In 2020, Washington utilities with more than 25,000 customers are required to source 15% of their energy from renewable resources.
<i>Technical Potential</i>	The set of possible conservation savings that includes all possible measures, regardless of market or cost barriers.
<i>Total Resource Cost (TRC) Test</i>	A test for cost-effectiveness that considers all costs and benefits, regardless of who they accrue to. A measure passes this test if the present value of all benefits exceeds the present value of all costs. The TRC test is required by Washington's Energy Independence Act and is the predominant cost effectiveness test used throughout the Northwest and U.S.

Appendix III: Compliance with State Requirements

This Appendix details the specific requirements for Conservation Potential Assessments listed in WAC 194-37-080. The table below lists the specific section and corresponding requirement along with a description of how the requirement is implemented in the model and where the implementation can be found.

Table 12: CPA Compliance with EIA Requirements

WAC 194-37-080 Section	Requirement	Implementation
(5)(a)	Technical potential. Determine the amount of conservation that is technically feasible, considering measures and the number of these measures that could physically be installed or implemented, without regard to achievability or cost.	The model calculates technical potential by multiplying the quantity of stock (number of homes, building floor area, industrial load) by the number of measures that could be installed per each unit of stock. The model further constrains the potential by the share of measures that have already been completed. See calculations in the “Units” tabs within each of the sector model files.
(5)(b)	Achievable technical potential. Determine the amount of the conservation technical potential that is available within the planning period, considering barriers to market penetration and the rate at which savings could be acquired.	The model applies maximum achievability factors based on the Council’s 2021 Power Plan assumptions and ramp rates to identify how the potential can be acquired over the 20-year study period. See calculations in the “Units” tabs within each of the sector model files. The complete set of the ramp rates used is on the “Ramp Rates” tab.
(5)(c)	Economic achievable potential. Establish the economic achievable potential, which is the conservation potential that is cost-effective, reliable, and feasible, by comparing the total resource cost of conservation measures to the cost of other resources available to meet expected demand for electricity and capacity.	Lighthouse used the Council’s ProCost model to calculate TRC benefit-cost ratios for each measure after updating ProCost with utility-specific inputs. The ProCost results are collected through an Excel macro in the “ProCost Measure Results-(scenario).xlsm” files and brought into the CPA models through Excel’s Power Query. See Appendix IV for further discussion of the avoided cost assumptions.
(5)(d)	Total resource cost. In determining economic achievable potential as provided in (c) of this subsection, perform a life-cycle cost analysis of measures or programs to determine the net levelized cost, as described in this subsection.	A life-cycle cost analysis was performed using the Council’s ProCost tool, which Lighthouse configured with utility-specific inputs. Costs and benefits were included consistent with the TRC test. The measure files within each sector contain the ProCost results. These results are then rolled up into the ProCost Measure Results files, which are

WAC 194-37-080 Section	Requirement	Implementation
		linked to each sector model file through Excel's Power Query functionality.
(5)(d)(i)	Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits.	The costs considered in the economic analysis included measure capital costs, O&M costs, periodic replacement costs, and any non-energy costs. Benefits included avoided energy, T&D capacity costs, avoided generation capacity costs, non-energy benefits, O&M savings, and periodic replacement costs. Measure costs and benefits can be found in the individual measure files as well as the "ProCost Measure Results" files.
(5)(d)(ii)	Include the incremental savings and incremental costs of measures and replacement measures where resources or measures have different measure lifetimes.	Assumed savings, cost, and measure lifetimes are based on 2021 Power Plan and subsequent RTF updates, where applicable. Measure costs and benefits can be found in the individual measure files as well as the "ProCost Measure Results" files.
(5)(d)(iii)	Calculate the value of the energy saved based on when it is saved. In performing this calculation, use time differentiated avoided costs to conduct the analysis that determines the financial value of energy saved through conservation.	Lighthouse used a 20-year forecast of monthly on- and off-peak market prices and the load shapes developed for the 2021 Power Plan as part of the economic analysis conducted in ProCost. The "MC and Loadshape" file contains both the market price forecast as well as the library of load shapes. Individual measure files contain the load shape assignments.
(5)(d)(iv)	Include the increase or decrease in annual or periodic operations and maintenance costs due to conservation measures.	Measure analyses include changes to O&M costs as well as periodic replacement costs, where applicable. These assumptions are based on the 2021 Plan and/or RTF. Measure assumptions can be found in the individual measure files.
(5)(d)(v)	Include avoided energy costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy efficiency measures to which it is compared.	Lighthouse developed a forecast of on- and off-peak market prices at the mid-Columbia trading hub. Further discussion of this forecast can be found in Appendix IV.

WAC 194-37-080 Section	Requirement	Implementation
		See the “MC and Loadshape” file for the market prices. These prices include the value of avoided REC purchases as applicable.
(5)(d)(vi)	Include deferred capacity expansion benefits for transmission and distribution systems.	Deferred transmission and distribution system benefits are based on the values developed by the Council for the 2021 Power Plan. These values can be found on the “ProData” tab of the ProCost files, cells C50 and C54.
(5)(d)(vii)	Include deferred generation benefits consistent with the contribution to system peak capacity of the conservation measure.	Deferred generation capacity expansion benefits are based on BPA’s monthly demand charges, which are used as a proxy for the cost of capacity. The development of these values is discussed in Appendix IV. These values can be found on the “ProData” tab of the ProCost files, cells C60.
(5)(d)(viii)	Include the social cost of carbon emissions from avoided non-conservation resources.	This assessment uses the social cost of carbon values determined by the federal Interagency Workgroup using a 2.5% discount rate, as required by the Clean Energy Transformation Act. The emissions intensity of energy savings is based on an updated Council analysis of the regional marginal emissions intensity. The carbon costs and emissions intensities can be found in the MC and Loadshape file.
(5)(d)(ix)	Include a risk mitigation credit to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources.	This analysis uses a scenario analysis to consider risk. Avoided cost values with uncertain future values were varied across three different scenarios and the resulting sensitivity and risk were analyzed. The Scenario Results section of this report discusses the inputs used and the implicit risk adders used in the analysis.
(5)(d)(x)	Include all non-energy impacts that a resource or measure may provide that can be quantified and monetized.	All quantifiable non-energy benefits were included where appropriate, based on values from the Council’s draft 2021 Plan materials and RTF. Measure assumptions can be found in the individual measure files.

WAC 194-37-080 Section	Requirement	Implementation
(5)(d)(xi)	Include an estimate of program administrative costs.	This assessment uses the Council’s assumption of administrative costs equal to 20% of measure capital costs. Program admin costs can be found in the “ProData” tab of the ProCost files, cell C29.
(5)(d)(xii)	Include the cost of financing measures using the capital costs of the entity that is expected to pay for the measure.	This assessment utilizes the financing cost assumptions from the draft 2021 Plan materials, including the sector-specific cost shares and cost of capital assumptions. Financing assumptions can be found in the ProData tab of the ProCost files, cells C37:F46.
(5)(d)(xiii)	Discount future costs and benefits at a discount rate equal to the discount rate used by the utility in evaluating non-conservation resources.	This assessment uses a real discount rate of 3.75% to determine the present value of all costs and benefits. This represents RES’s long-term cost of capital. The discount rate used in this analysis can be found in the ProCost files, on cell C27 of the ProData tab.
(5)(d)(xiv)	Include a ten percent bonus for the energy and capacity benefits of conservation measures as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act.	A 10% bonus is applied consistent with the Northwest Power Act. The 10% credit used in the measure analyses can be found in the ProCost files, on cell C29 of the ProData tab.

Appendix IV: Avoided Costs

The methodology used to conduct conservation potential assessments for electric utilities in the State of Washington is dictated by the requirements of the Energy Independence Act (EIA) and the Clean Energy Transformation Act (CETA). Specifically, WAC 194-37-070 requires utilities to determine the economic, or cost-effective, potential by “comparing the total resource cost of conservation measures to the total cost of other resources available to meet expected demand for electricity and capacity.”⁷ This CPA will determine the cost-effectiveness of conservation measures through a benefit-cost ratio approach, which uses avoided costs to represent the costs avoided by acquiring efficiency instead of other resources. The EIA specifies that these avoided costs include the following components:

- Time-differentiated energy costs equal to a forecast of regional market prices
- Deferred capacity expansion costs for the transmission and distribution system
- Deferred generation capacity costs consistent with each measure’s contribution to system peak capacity savings
- The social cost of carbon emissions from avoided non-conservation resources
- A risk mitigation credit to reflect the additional value of conservation not accounted for in other inputs
- A 10% bonus for energy and capacity benefits of conservation measures, as defined by the Pacific Northwest Electric Power Planning and Conservation Act

In addition to these requirements, Washington’s CETA requires specific values be used for the social cost of carbon.⁸ Lighthouse has also included the value of avoided renewable portfolio standard compliance costs in the avoided costs.

This memo discusses each of these inputs in detail in the following sections.

Avoided Energy Costs

Avoided energy costs are the energy costs avoided by RES through the acquisition of energy efficiency instead of supply-side resources. For every megawatt-hour of conservation achieved, RES will avoid the purchase of one megawatt-hour of energy.

For this CPA, Lighthouse has developed a forecast of avoided on- and off-peak energy prices at the Mid-Columbia trading hub. The forecast is based on forward on- and off-peak prices reported by the CME Group^{9,10} on March 1, 2023. The prices cover the current year through 2028.

To develop a forecast that would cover the 20-year study period of this CPA, Lighthouse developed a set of multipliers that would transition the prices in 2028 to the mid-range of longer-term prices expected in the Northwest Power & Conservation Council’s most recent market price forecast.¹¹ Lighthouse identified this approach as a good balance that reflected both the near-term high prices and volatility while also including

⁷ WAC 194-37-070. Accessed January 20, 2021. <https://app.leg.wa.gov/wac/default.aspx?cite=194-37-070>

⁸ WAC 194-40-100. Accessed March 7, 2023. <https://app.leg.wa.gov/WAC/default.aspx?cite=194-40-100>

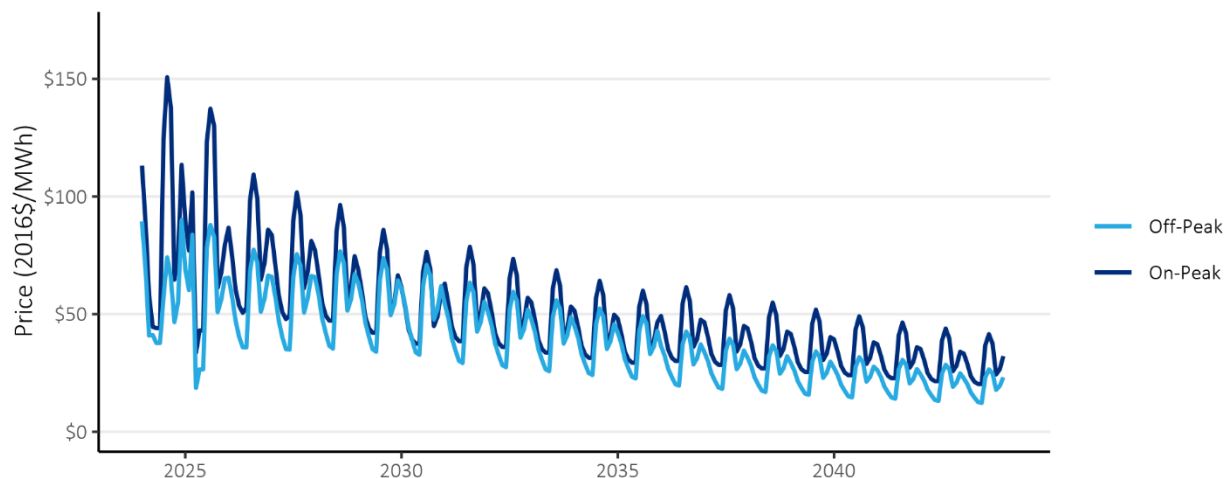
⁹ <https://www.cmegroup.com/trading/energy/electricity/mid-columbia-day-ahead-peak-calendar-month-5-mw-futures.html>. Accessed March 1, 2023.

¹⁰ <https://www.cmegroup.com/trading/energy/electricity/mid-columbia-day-ahead-off-peak-calendar-month-5-mw-futures.html>. Accessed March 1, 2023.

¹¹ https://www.nwcouncil.org/fs/18190/2023_02_p3.pdf. Accessed March 3, 2023.

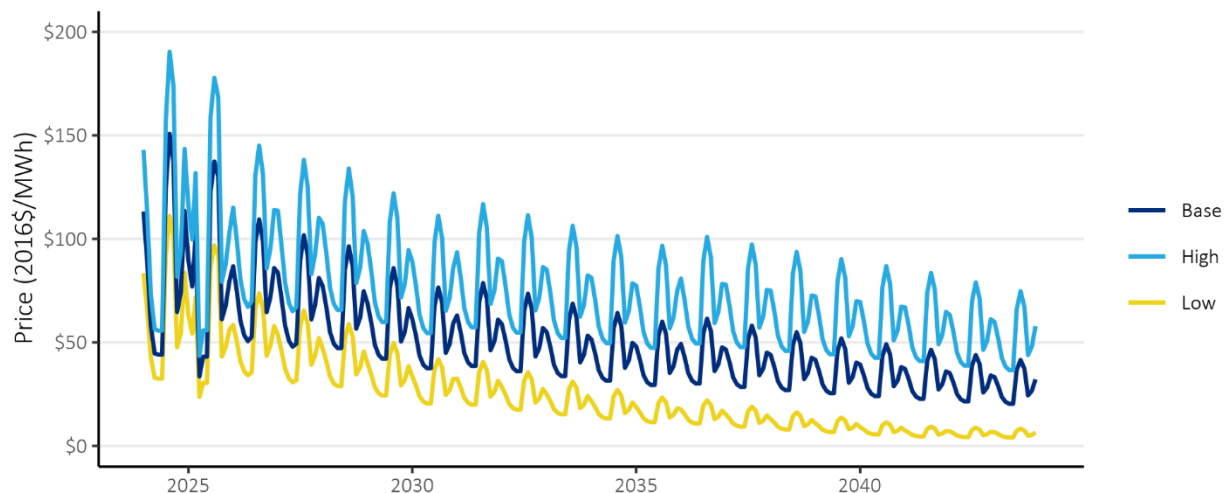
the longer-term forecast based on market fundamentals from the Council. Figure 22 shows the resulting on- and off-peak prices resulting from this process.

Figure 22: On- and Off-Peak Price Forecast



The levelized value of the 20-year price forecast is \$47/MWh (2016\$). In RES's 2021 CPA, the levelized value of market prices was approximately \$35/MWh (2016\$), an increase of 34%.

Lighthouse also created high and low variations of this forecast to be used in the avoided cost scenarios, which are described subsequently. To develop the forecast variations, Lighthouse assumed that the high and low prices would vary by approximately 20% in the near term and 80% in the long term, relative to the base case price forecast. A similar approach was used in RES's 2021 CPA based on the variation observed in price forecasts in the 2021 Power Plan. Lighthouse applied this variation to the forecast described above to create high and low scenario forecasts. The resulting forecasts for on- and off-peak prices are shown in Figure 23: **Comparison of On-Peak Price Scenarios**



and Figure 24 below.

Figure 23: Comparison of On-Peak Price Scenarios

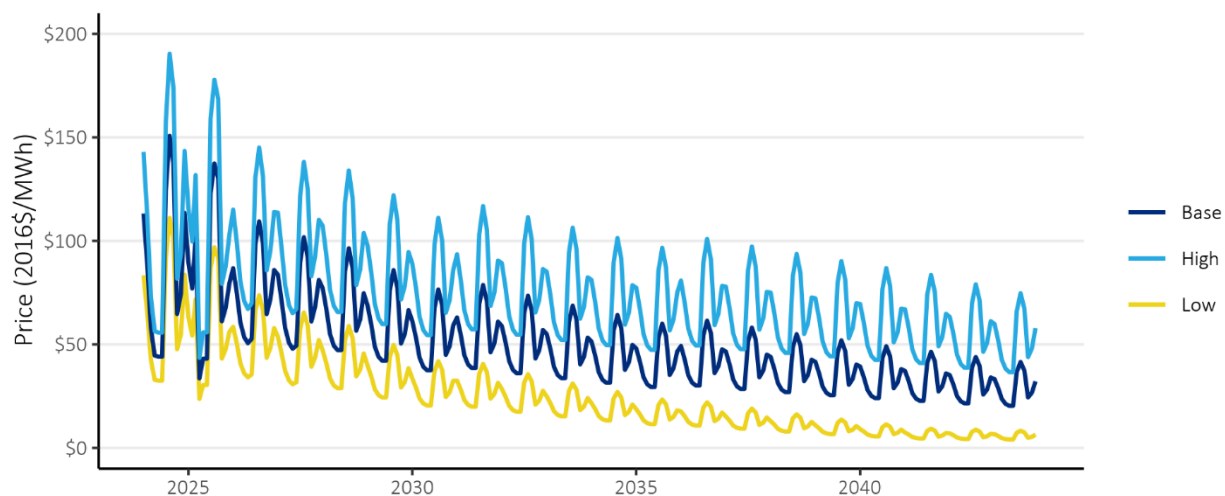
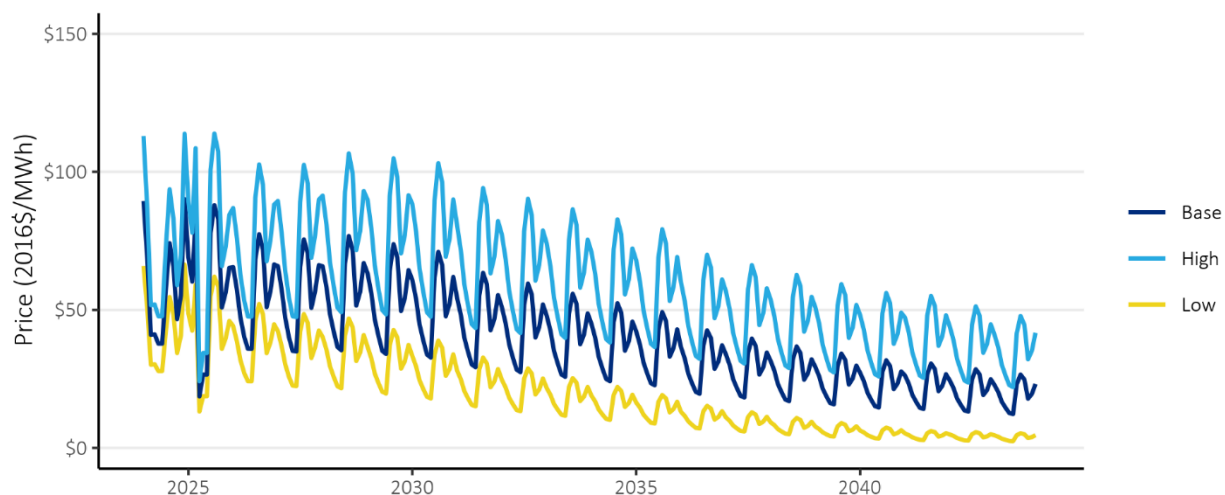


Figure 24: Comparison of Off-Peak Price Scenarios



Deferred Transmission and Distribution Capacity Costs

Unlike supply-side resources, energy efficiency does not require transmission and distribution infrastructure. Instead, it frees up capacity in these systems by reducing the peak demands and over time can help defer future capacity expansions and the associated capital costs.

In the development of the 2021 Power Plan, the Council surveyed Northwest utilities to update the values associated with these cost deferrals. The resulting values were \$3.54/kW-year for transmission capacity and \$7.82/kW-year for distribution capacity (2016\$). These values were used in RES's 2019 and 2021 CPAs and will be used again in this assessment across all avoided cost scenarios.

These are applied to demand savings coincident with the timing of the respective transmission and distribution system peaks.

Deferred Generation Capacity Costs

Similar to the transmission and distribution systems discussed above, acquiring energy efficiency resources can also help defer or eliminate the costs of new generation resources built or acquired to meet peak demands for electricity. While there is currently no organized capacity market in the Northwest, RES does pay a demand charge to BPA based on its monthly peak demand. These charges effectively function as a generation capacity value for RES.

Lighthouse followed a methodology similar to what was used in RES's previous CPAs to convert BPA's monthly demand charges to an annual generation capacity value. Using assumptions about energy efficiency capacity contributions by month, BPA's 2022-2023 monthly demand charges were scaled and added to calculate an annual value. In the base case, Lighthouse assumed that these demand charges would increase by 2% each year to calculate a 20-year series of annual generation capacity values and then levelized them to provide a single value that is required for the Council's ProCost model. This resulted in a base case value of \$79/kW-year, a slight decrease from the value used in the 2021 CPA, which was \$88/kW-year.

For the low case, a price escalation of 0.4% was assumed, resulting in a value of \$69/kW-year. In the high scenario, Lighthouse used Council's 2021 Power Plan value, which is \$123/kW-year. This value reflects the levelized cost of capacity for a battery storage system after accounting for projected cost declines in the future.

Social Cost of Carbon

In addition to avoiding purchases of energy, energy efficiency measures avoid emissions of greenhouse gases like carbon dioxide. Washington's EIA requires that CPAs include the social cost of carbon, which the US EPA defines as a measure of the long-term damage done by a ton of carbon dioxide emissions in a given year. The EPA describes it as including, among other things, changes in agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, including increases in the costs of cooling and decreases in heating costs.¹² In addition to this requirement, Washington's CETA requires that utilities use the social cost of carbon values developed by the federal Interagency workgroup using a 2.5% discount rate. These values were used in all scenarios of the CPA.

To implement a cost of carbon emissions, additional assumptions must be made about the intensity of carbon emissions associated with a marginal unit of energy. This assessment uses an updated forecast of marginal emissions rates developed by the Council in 2022. The values from this analysis are used for years before 2030. Beginning in 2030, the marginal emissions rate is set to zero to reflect that CETA requires carbon-free energy. The Council's updated values generally follow those used in the 2021 Power Plan and the District's 2021 CPA, but are now available on a more granular basis, reflecting variations by month and on- and off-peak periods.

¹² https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf. Accessed January 21, 2021.

Renewable Portfolio Standard Compliance Costs

The renewable portfolio standard established under Washington's EIA requires that utilities source a portion of retail sales from renewable resources throughout the study period of this CPA. For RES, the requirement begins at 3% for the years 2026 through 2029. The subsequently passed CETA furthers these requirements, mandating that 100% of sales be greenhouse gas neutral in 2030, with an allowance that up to 20% of the requirement can be achieved through other options, such as the purchase of Renewable Energy Credits (RECs).

Energy efficiency can reduce the cost of complying with these requirements by reducing RES's overall load. In 2026, a reduction in load of 100 MWh through energy efficiency would reduce the number of RECs required for compliance by 3. This equates to a value of 3% of the cost of a REC for every megawatt-hour of energy savings. In 2030, it was assumed that marginal energy purchases would also include the purchase of a REC, thus the full price of a REC was added to the energy price beginning in 2030.

Lighthouse developed a forecast of REC prices based on input from several clients.

Risk Mitigation Credit

Any purchase of a resource involves risk. The decision to invest is based on uncertain forecasts of loads and market conditions. Investing in energy efficiency can reduce the risks that utilities face by the fact that it is made in small increments over time, rather than the large, singular sums required for generation resources. A decision not to invest in energy efficiency could result in exposure to higher market prices than forecast, an unneeded infrastructure investment, or one that cannot economically dispatch due to low market prices. While over-investments in energy efficiency are possible, the small and discrete amounts invested in energy efficiency limit the scale of any exposure to this risk.

In its power planning work, the Council develops a risk mitigation credit to account for this risk. This credit accounts for the value of energy efficiency not explicitly included in the other avoided cost values, ensuring that the level of cost-effective energy efficiency is consistent with the outcomes of the power planning process and the conservation targets set by the Council. The value of the credit is determined by identifying a value that results in a level of cost-effective energy efficiency potential that is equivalent to the regional targets set by the Council.

In the 2021 Power Plan, the Council determined that no risk credit was necessary after including carbon costs and a generation capacity value in its avoided cost.

This CPA follows the process used in RES's previous CPAs and is similar to the process followed by the Council. A scenario analysis is used to account for uncertainty, where present, in avoided cost values. The variation in energy and capacity avoided cost inputs covers a range of possible outcomes and the sensitivity of the cost-effective energy efficiency potential is identified by comparing the outcomes of each scenario. In selecting its biennial target based on this range of outcomes, RES is selecting its preferred risk strategy and the associated risk credit.

Northwest Power Act Credit

Finally, this CPA includes a 10% cost credit for energy efficiency. This credit is specified in the Pacific Northwest Electric Power Planning and Conservation Act for regional power planning work completed by the Council and by Washington's EIA for CPAs completed for Washington utilities. This credit is applied as a 10% bonus to the energy and capacity benefits described above.

Summary

Table 13 summarizes the avoided cost assumptions used in each of the scenarios in this CPA update.

Table 13: Avoided Cost Assumptions by Scenario

		Low Scenario	Base Scenario	High Scenario
Energy Values	Avoided Energy Costs (20-Year Levelized Price, 2016\$)	Market Forecast minus 20%-80% (\$25)	Market Forecast (\$47)	Market Forecast plus 20%-80% (\$70)
	Social Cost CO ₂	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
	RPS Compliance	WA EIA & CETA Requirements	WA EIA & CETA Requirements	WA EIA & CETA Requirements
Capacity Values	Distribution Capacity (2016\$)	\$7.82/kW-year	\$7.82/kW-year	\$7.82/kW-year
	Transmission Capacity (2016\$)	\$3.54/kW-year	\$3.54/kW-year	\$3.54/kW-year
	Generation Capacity (2016\$)	\$69/kW-year	\$79/kW-year	\$123/kW-year
	Implied Risk Adder (2016\$)	-\$22/MWh -\$10/kW-year	N/A	\$23/MWh \$44/kW-year
	NW Power Act Credit	10%	10%	10%

Appendix V: Measure List

This appendix provides a list of the measures that were included in this assessment and the data sources that were used for any measure characteristics. The assessment used all measures from the 2021 Power Plan that were applicable to RES. Lighthouse customized these measures to make them specific to RES's service territory and updated many with new information available from the RTF. The RTF continually updates estimates of measure savings and cost. This assessment used the most up to date information available when the CPA was developed.

This list is high-level and does not reflect the thousands of variations for each individual measure. Instead, it summarizes measures by category. Many measures include variations specific to different home or building types, efficiency level, or other characterization. For example, attic insulation measures are differentiated by home type (e.g., single family, multifamily, manufactured home), heating system (e.g., heat pump or furnace), baseline insulation level (e.g., R0, R11, etc.) and maximum insulation possible (e.g., R22, R30, R38, R49). This differentiation allows for savings and cost estimates to be more precise.

The measure list is grouped by sector and end use. Note that all measures may not be applicable to an individual utility service territory based on the characteristics of individual utilities and their customer sectors.

Table 14: Residential End Uses and Measures

End Use	Measure Category	Data Source(s)
Appliances	Air Cleaner	2021 Power Plan, RTF
	Clothes Washer	2021 Power Plan, RTF
	Clothes Dryer	2021 Power Plan, RTF
	Freezer	2021 Power Plan
	Refrigerator	2021 Power Plan
Cooking	Electric Oven	2021 Power Plan
	Microwave	2021 Power Plan
Electronics	Advanced Power Strips	2021 Power Plan, RTF
	Desktop	2021 Power Plan
	Laptop	2021 Power Plan
	Monitor	2021 Power Plan
	TV	2021 Power Plan
EVSE	EVSE	2021 Power Plan
HVAC	Air Source Heat Pump	2021 Power Plan
	Central Air Conditioner	2021 Power Plan
	Cellular Shades	2021 Power Plan
	Circulator	2021 Power Plan
	Circulator Controls	2021 Power Plan
	Ductless Heat Pump	2021 Power Plan, RTF
	Duct Sealing	2021 Power Plan, RTF
	Ground Source Heat Pump	2021 Power Plan
	Heat Recovery Ventilator	2021 Power Plan
	Room Air Conditioner	2021 Power Plan
	Smart Thermostats	2021 Power Plan, RTF
	Weatherization	2021 Power Plan, RTF
	Whole House Fan	2021 Power Plan
Lighting	Fixtures	2021 Power Plan, RTF
	Lamps	2021 Power Plan, RTF
	Pin Lamps	2021 Power Plan, RTF
Motors	Well Pump	2021 Power Plan
Water Heat	Aerators	2021 Power Plan, RTF
	Circulator	2021 Power Plan
	Circulator Controls	2021 Power Plan
	Dishwasher	2021 Power Plan
	Gravity Film Heat Exchanger	2021 Power Plan
	Heat Pump Water Heater	2021 Power Plan, RTF
	Pipe Insulation	2021 Power Plan
	Showerhead	2021 Power Plan
	Thermostatic Restrictor Valve	2021 Power Plan, RTF
Whole Home	Behavior	2021 Power Plan

Table 15: Commercial End Uses and Measures

End Use	Measure Category	Data Source(s)
Compressed Air	Air Compressor	2021 Power Plan
Electronics	Computers	2021 Power Plan
	Power Supplies	2021 Power Plan
	Smart Power Strips	2021 Power Plan, RTF
	Servers	2021 Power Plan
Food Preparation	Combination Ovens	2021 Power Plan, RTF
	Convection Ovens	2021 Power Plan, RTF
	Fryers	2021 Power Plan, RTF
	Griddle	2021 Power Plan, RTF
	Hot Food Holding Cabinet	2021 Power Plan, RTF
	Overwrapper	2021 Power Plan
	Steamer	2021 Power Plan, RTF
HVAC	Advanced Rooftop Controller	2021 Power Plan, RTF
	Chiller	2021 Power Plan
	Circulation Pumps	2021 Power Plan, RTF
	Ductless Heat Pump	2021 Power Plan
	Energy Management	2021 Power Plan
	Fans	2021 Power Plan
	Heat Pumps	2021 Power Plan
	Package Terminal Heat Pumps	2021 Power Plan
	Pumps	2021 Power Plan, RTF
	Smart Thermostats	2021 Power Plan
	Unitary Air Conditioners	2021 Power Plan
	Very High Efficiency Dedicated Outside Air System	2021 Power Plan
	Variable Refrigerant Flow Dedicated Outside Air System	2021 Power Plan
	Windows	2021 Power Plan
Lighting	Exit Signs	2021 Power Plan
	Exterior Lighting	2021 Power Plan
	Garage Lighting	2021 Power Plan
	Interior Lighting	2021 Power Plan
	Stairwell Lighting	2021 Power Plan
	Streetlights	2021 Power Plan
Motors & Drives	Pumps	2021 Power Plan, RTF
Process Loads	Elevators	2021 Power Plan
	Engine Block Heater	2021 Power Plan, RTF
Refrigeration	Freezer	2021 Power Plan
	Grocery Refrigeration	2021 Power Plan, RTF
	Ice Maker	2021 Power Plan, RTF
	Refrigerator	2021 Power Plan, RTF
	Vending Machine	2021 Power Plan, RTF
	Water Cooler Controls	2021 Power Plan
Water Heating	Commercial Clothes Washer	2021 Power Plan, RTF
	Heat Pump Water Heater	2021 Power Plan, RTF
	Pre-Rinse Spray Valve	2021 Power Plan, RTF
	Pumps	2021 Power Plan, RTF
	Showerheads	2021 Power Plan

Table 16: Industrial End Uses and Measures

End Use	Measure Category	Data Source(s)
All Electric	Energy Management	2021 Power Plan
	Forklift Charger	2021 Power Plan
	Water/Wastewater	2021 Power Plan
Compressed Air	Air Compressor	2021 Power Plan
	Air Compressors	2021 Power Plan
	Compressed Air Demand Reduction	2021 Power Plan
Fans and Blowers	Fan Optimization	2021 Power Plan
	Fans	2021 Power Plan, RTF
HVAC	HVAC	2021 Power Plan
Lighting	High Bay Lighting	2021 Power Plan
	Lighting	2021 Power Plan
	Lighting Controls	2021 Power Plan
Low Temp Refer	Motors	2021 Power Plan
	Refrigeration Retrofit	2021 Power Plan
Material Handling	Motors	2021 Power Plan
	Paper	2021 Power Plan
	Wood Products	2021 Power Plan
Material Processing	Hi-Tech	2021 Power Plan
	Motors	2021 Power Plan
	Paper	2021 Power Plan
	Pulp	2021 Power Plan
	Wood Products	2021 Power Plan
Med Temp Refer	Food Storage	2021 Power Plan
	Motors	2021 Power Plan
	Refrigeration Retrofit	2021 Power Plan
Melting and Casting	Metals	2021 Power Plan
Other	Pulp	2021 Power Plan
Other Motors	Motors	2021 Power Plan
Pollution Control	Motors	2021 Power Plan
Pumps	Pulp	2021 Power Plan
	Pump Optimization	2021 Power Plan
	Pumps	2021 Power Plan, RTF

Table 17: Utility Distribution End Uses and Measures

End Use	Measure Category	Data Source
Distribution	Line Drop Control with no Voltage/VAR Optimization	2021 Power Plan
	Line Drop Control with Voltage Optimization & AMI	2021 Power Plan

Appendix VI: Energy Efficiency Potential by End Use

The tables in this appendix document the cost-effective energy efficiency savings potential by end use for each sector.

Table 18: Residential Potential by End Use (MWh)

End Use	2-Year	4-Year	10-Year	20-Year
Appliances	361	991	4,885	17,391
Cooking	2	7	70	379
Electronics	97	281	1,523	2,229
EV Supply Equipment	-	-	-	-
HVAC	966	2,658	16,070	48,338
Lighting	41	121	776	3,257
Motors	-	-	-	-
Water Heat	494	1,409	6,797	15,820
Whole Home	-	-	-	-
Total	1,961	5,467	30,121	87,415

Table 19: Commercial Potential by End Use (MWh)

End Use	2-Year	4-Year	10-Year	20-Year
Compressed Air	3	13	143	687
Electronics	38	147	1,622	3,648
Food Preparation	2	10	122	737
HVAC	464	1,633	12,825	42,355
Lighting	2,162	4,918	15,446	31,911
Motors/Drives	34	121	1,010	3,416
Process Loads	-	-	-	-
Refrigeration	211	726	5,725	15,972
Water Heating	8	30	334	1,725
Total	2,922	7,598	37,227	100,452

Table 20: Industrial Potential by End Use (MWh)

End Use	2-Year	4-Year	10-Year	20-Year
All Electric	413	1,410	7,139	10,375
Compressed Air	176	533	2,730	5,374
Fans and Blowers	151	401	1,807	4,942
HVAC	33	110	769	1,508
Lighting	380	1,302	6,230	8,394
Low Temp Refrigeration	123	415	3,035	7,181
Material Handling	1	3	35	197
Material Processing	3	12	139	785
Med Temp Refrigeration	35	118	870	2,115
Melting and Casting	1	5	33	65
Other	0	0	0	0
Other Motors	1	5	56	322
Pollution Control	0	0	5	27
Pumps	53	188	1,660	6,295
Total	1,369	4,503	24,508	47,582

Table 21: Utility Distribution System Potential by End Use (MWh)

End Use	2-Year	4-Year	10-Year	20-Year
LDC with no VVO	66	215	1,435	2,720
LDC with VVO & AMI	220	722	4,811	9,119
Total	285	937	6,246	11,839

Appendix VII: Ramp Rate Alignment Documentation

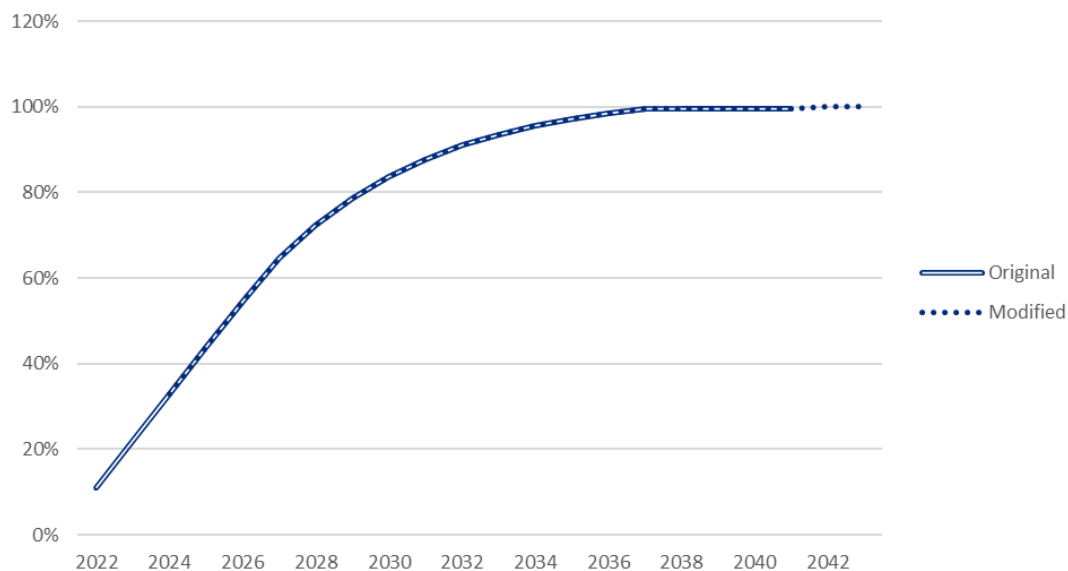
This appendix documents how Lighthouse adjusted the ramp rates from the 2021 Power Plan to be applicable to the 2024-43 time period of this CPA and then selected appropriate adjusted ramp rates to align the near-term potential quantified in Richland Energy Services' (RES) CPA with its recent energy efficiency achievements. Aligning the potential with recent achievements provides the best way to ensure that the near-term potential is feasible for RES's programs as energy efficiency programs take time to ramp up and are subject to local market conditions.

Ramp Rate Adjustments

The CPA model used for this assessment uses the ramp rates developed by the Northwest Power and Conservation Council for the 2021 Power Plan. The 2021 Power Plan, however, covers an earlier time period and so the ramp rates require adjustment to correspond to the 2024-43 time period of this CPA.

There are two different types of ramp rates, which correspond with the two types of measure under consideration. For lost opportunity measures that are associated with equipment replacement cycles or new construction, the ramp rate values reflect the amount of energy efficiency potential captured among the equipment being purchased in a given year. These ramp rates typically approach 100% in the later years and were adjusted to cover the timeline of the CPA by simply extending the final value of the ramp rate an additional two years. Figure 25 shows how one lost opportunity ramp rate was modified to cover the 2024-43 timeline of this CPA. The original ramp rate reaches 100% at approximately 2037 and the modified ramp rate simply extends this trend for another two years.

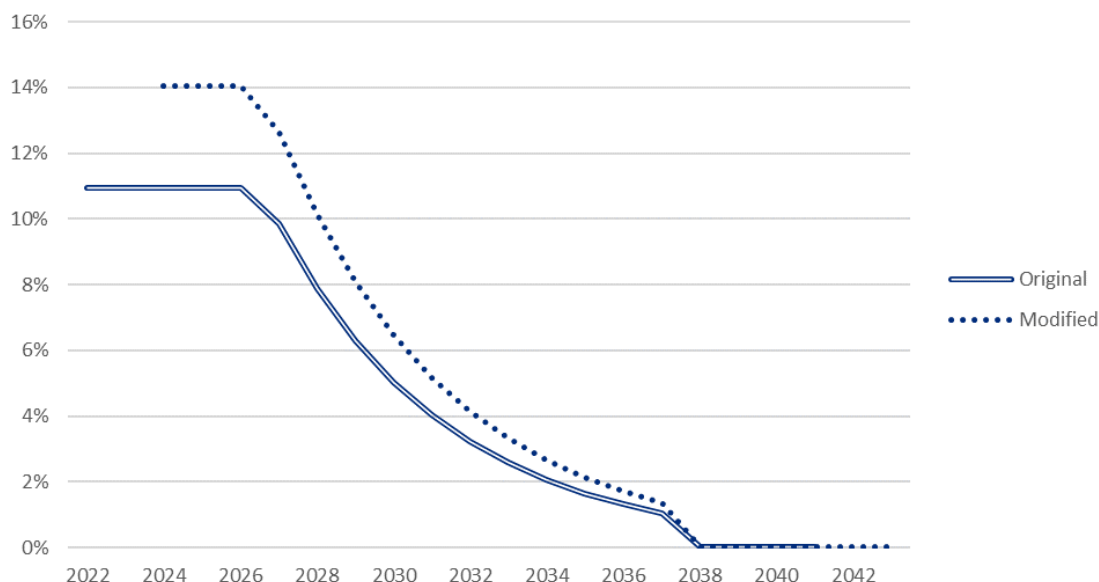
Figure 25: Lost Opportunity Ramp Rate Adjustment



For retrofit measures, the ramp rate values reflect the portion of the total available potential that is achieved in a given year. Because retrofit measures can be achieved in any year, the ramp rate values typically sum to 100% over a 20-year time period. To adjust the ramp rates for retrofit measures, Lighthouse assumed that the potential associated with the first two years of the 2021 Power Plan had been achieved and the remaining potential was distributed across the 18 remaining years of the original 2021 Power Plan

timeline, in proportion to the original ramp rate projection. This results in higher ramp rate values relative to the original 2021 Power Plan, but equivalent amounts of potential after program achievements have been accounted for. Figure 26 shows the original and modified versions of one retrofit measure ramp rate.

Figure 26: Retrofit Ramp Rate Adjustment



For this ramp rate, nearly 100% of the remaining potential is captured by 2038 in both the original and modified versions of the ramp rate.

Ramp Rate Alignment Process

RES provided program achievement data for 2021-22, which Lighthouse summarized by sector and end use. Lighthouse also summarized the residential program achievements by high-level measure categories.

RES also receives credit for savings from market transformation that the Northwest Energy Efficiency Alliance (NEEA) estimates has occurred in RES' service territory. These savings were allocated to customer sectors based on the historical makeup of the savings but could not be allocated within end uses or measure categories. Because of this, in the tables below, NEEA's historical savings are included on a designated row, but future potential is not distinguished between NEEA and RES programs. For example, Lighthouse has no way to determine the future split of savings from ductless heat pumps or heat pump water heaters between RES programs and NEEA market transformation savings.

Lighthouse has a general sense of NEEA's initiatives, however, and can therefore identify the end uses or measures where NEEA's market transformation initiatives may contribute additional savings. These are noted in the discussion below.

Lighthouse compared the recent savings from RES's programs and NEEA's market transformation initiatives with the cost-effective energy efficiency potential identified in the 2023 CPA. Lighthouse started with the ramp rates that were assigned to each measure in the 2021 Power Plan and compared the resulting cost-effective potential in the first few years of the assessment with RES' recent programmatic achievements. Lighthouse then made changes to the ramp rate assignments for each measure to accelerate or decelerate the pace of savings acquisition to align with recent programmatic achievements. In areas where there were

no recent program achievements, Lighthouse typically assigned a slower ramp rate, if one was not already assigned, to account for the fact that a program may need to start from scratch and build momentum over several years.

NEEA resets the baseline against which it quantifies its market transformation savings with every new Power Plan. This happened in 2022 with the publication of the 2021 Power Plan. For consistency in projecting future savings, Lighthouse assumed a similar level of NEEA savings in 2021 as in 2022. This level of savings best represents the expected level of savings going forward with the 2021 Power Plan baseline.

The following tables show how RES' recent achievements compare to the potential after Lighthouse adjusted the ramp rates to align. Color scaling has been applied to highlight the larger values. Discussion follows each table with additional detail.

Residential

The table below shows how the residential potential was aligned with recent achievements by measure category.

Table 22: Alignment of Residential Program History and Potential by Measure Category (MWh)

End Use	Category	Program History		CPA Cost-Effective Potential		
		2021	2022	2024	2025	2026
Appliances	Air Cleaner			7	11	15
Appliances	Clothes Washer			60	83	104
Appliances	Dryer			50	76	108
Appliances	Freezer			7	10	12
Appliances	Refrigerator			24	33	41
Cooking	Microwave			0	1	1
Cooking	Oven			0	0	1
Electronics	Laptop			0	1	1
Electronics	TV			39	57	78
EVSE	EVSE	-	0.3	-	-	-
HVAC	ASHP	859	549	2	4	4
HVAC	Central AC			1	3	4
HVAC	Circulator			0	0	0
HVAC	Circulator Controls			0	0	0
HVAC	DHP	38	48	232	231	229
HVAC	Duct Sealing			44	78	131
HVAC	Thermostat			56	124	233
HVAC	Weatherization	65	87	86	104	124
Lighting	Lighting			17	25	34
Water Heat	Circulator			0	0	0
Water Heat	Circulator Controls			0	1	1
Water Heat	Dishwasher			2	2	3
Water Heat	HPWH	-	35	185	279	370
Water Heat	TSRV			9	16	25
NEEA	NEEA	628	628	n/a	n/a	n/a
Total		1,590	1,347	824	1,137	1,521

Note: For clarity, measure categories with no program achievements and no cost-effective potential have been removed. In addition, note that some measures have savings values that are small and cannot be shown at this level of resolution. These values show as 0 in this and following tables while a true zero value is shown as a dash.

The following sections discuss the alignment within each residential end use.

Appliances & Cooking

While there are no program achievements in these end uses, NEEA's market transformation work includes an initiative for retail products and appliances that targets these measures. The ramp rate assignments for these measures were mostly left at the default 2021 Power Plan assignments. Only the ramp rate for clothes dryers was slowed, as this category includes heat pump dryers that have gained a limited market share to date.

Electronics

The potential in this end use is limited to TVs and laptops. The potential from TVs will likely be achieved through NEEA's Retail Product Portfolio, similar to the appliance end use discussed above. Lighthouse slowed the ramp rate for laptops since there is no current program or NEEA initiative that would address this category of measures.

HVAC

In the HVAC end use, as with RES' 2021 CPA, only certain applications of air-source heat pumps (ASHP) were cost-effective, limiting the ability to match recent program achievement and future potential. However, the tax credits and incentives provided for heat pumps through the federal Inflation Reduction Act have the potential to make these measures cost-effective, especially the more generous incentives provided to income-qualified households. The measures in this category were accelerated to align with recent program activity as much as possible.

The potential with ductless heat pumps (DHP) was also accelerated as this is another area where NEEA's market transformation work contributes some additional savings. The potential with duct sealing, smart thermostats, and weatherization was given slower ramp rates to align with recent program activity. Similar to the ASHP category discussed above, there is limited weatherization potential that passed the cost-effectiveness test.

Like RES's 2021 CPA, a measure for efficient central air conditioning systems was found to be cost-effective, but this measure was given a slow ramp rate since there is currently no program for this measure and, given the need for future fuel switching under Washington's Climate Commitment Act, RES may prefer to steer customers to heat pump technologies.

Lighting

The lighting end use is now subject to Washington state standards that took effect in 2020 covering many screw-in lamps. While there is potential that remains in fixtures with integrated LEDs and less common bulb types, there is not currently a program to incentivize LED fixtures, so these measures were given a slower ramp rate.

Water Heat

The cost-effective potential in the water heating category consists mostly of savings from heat pump water heaters. While RES has recently ramped up their program activity in this area, it is also an area where NEEA has a market transformation initiative which contributes additional savings. Lighthouse applied the default 2021 Power Plan ramp rates to the heat pump water heater measures.

Washington's recent HB 1444 specified standards for showerheads and aerators, so there is no longer potential in these measure categories. Lighthouse applied slower ramp rates to the thermostatic restrictor valve and other measures in this end use.

Table 23 below summarizes the residential measure category results in Table 22 by end use.

Table 23: Alignment of Residential Program History and Potential by End Use (MWh)

Program History			CPA Cost-Effective Potential		
End Use	2021	2022	2024	2025	2026
Appliances	-	-	149	212	279
Cooking	-	-	1	1	2
Electronics	-	-	39	58	79
EVSE	-	0.3	-	-	-
HVAC	962	684	423	543	727
Lighting	-	-	17	25	34
Water Heat	-	35	196	298	400
NEEA	628	628	n/a	n/a	n/a
Total	1,590	1,347	824	1,137	1,521

Commercial

In the commercial sector, RES' savings declined in 2020 due to the pandemic and are returning to normal levels. RES' recent achievement is in the lighting and HVAC end uses, which are the end uses with most of the future savings potential. Lighthouse applied slower ramp rates to measures throughout the commercial sector.

Table 24 below shows the alignment of program history and potential in the commercial sector.

Table 24: Alignment of Commercial Program History and Potential by End Use (MWh)

Program History			CPA Cost-Effective Potential		
End Use	2021	2022	2024	2025	2026
Compressed Air			1	2	4
Electronics			13	25	42
Food Preparation			1	2	3
HVAC	399	186	168	296	471
Lighting	1,623	1,009	1,003	1,159	1,319
Motors/Drives			13	22	35
Refrigeration			78	132	208
Water Heat			3	5	9
NEEA	165	165	-	-	-
Total	2,187	1,360	1,281	1,642	2,090

Industrial

Energy efficiency programs in the industrial sector are subject to ups and downs depending on the projects that are completed in a given year. The potential in RES' industrial sector is distributed across a variety of end uses, including lighting, energy management, and refrigeration. Lighthouse applied slower ramp rates to the potential across the industrial sector.

Table 25 shows the alignment of industrial potential and recent program history by end use.

Table 25: Alignment of Industrial Program History and Potential by End Use (MWh)

Program History			CPA Cost-Effective Potential		
End Use	2021	2022	2024	2025	2026
Energy Management	-	746	150	263	412
Compressed Air	138	-	72	104	151
Fans and Blowers	-	109	66	85	109
HVAC	-	-	12	20	31
Lighting	294	20	137	243	382
Motors	-	-	0	1	1
Refrigeration	-	-	59	99	153
Process	211	-	2	3	6
Pumps	-	156	19	33	54
Other	-	-	0	0	0
NEEA	3	3	n/a	n/a	n/a
Total	646	1,034	518	851	1,299

Utility Distribution System

The amount of potential in this sector is limited compared to other sectors. No changes were made to the default ramp rate assigned in the 2021 Power Plan.

Table 26: Alignment of Distribution System Program History and Potential by End Use (MWh)

Program History			CPA Cost-Effective Potential		
End Use	2021	2022	2024	2025	2026
Distribution System	-	-	109	177	268



UTILITY ADVISORY COMMITTEE AGENDA ITEM COVERSHEET

Meeting Date: 9/12/2023

Agenda Category: Items of Business

Prepared By: Pete Rogalsky, Public Works Director

Subject:

Solid Waste Regional Services (45 minutes)

Department:

Public Works

Recommended Motion:

Summary:

In recent years, the City has successfully completed and closed the landfill capacity originally permitted in the early 1970's. In 2017, the City decided to expand landfill operations on the same parcel that included the original landfill to supply its future waste disposal needs. At the time of this decision, rate modelling suggested that a series of 3 - 5% rate increases would be needed over a five-year period to fund the capital improvements necessary to establish the new landfill capacity. Now, in 2023, the City has been operating in the new landfill expansion for more than two years and has not raised service rates since 2015. Operational efficiency, capital improvement cost savings, and landfill revenue growth due to a strong regional economy have all contributed to the ability to hold rates steady and to validate the decision to expand landfill capacity within the City rather than export waste to regional landfills.

Solid Waste service costs are largely driven by transportation costs. Rising petroleum fuel prices and related state and federal climate policies are putting upward pressure on solid waste service costs. The City's local landfill insulates it from the increases in transportation related expenses that would be imposed for out of area waste disposal. The City's neighboring communities are served by waste haulers that transport their waste to regional landfills and absorb the costs associated with that arrangement.

State and federal climate policies are focusing on landfills as sources of methane emissions. At the same time, methane generated at landfills is classified as a biofuel and has an attractive market price generated by regulatory compliance obligations. Later this fall, the City will begin operation of a landfill gas polishing system that will eliminate methane emissions from the closed landfill and generate approximately \$72,000 in annual revenue. This new revenue is available because the City attracted a private investment partner to provide the landfill gas polishing plant in exchange for the opportunity to market the gas. Eliminating emissions, avoiding regulatory burdens over ongoing emissions, and generating revenue will turn a potentially burdensome element of landfill operations into an asset that offsets other costs.

New Washington State law establishes an aggressive goal to reduce methane emissions from landfills by removing organic waste content from landfill disposal. A majority of the Tri-Cities region will fall under regulations in the next five years that requires source separation and processing of food waste and organic waste. If new organic waste processing facilities are developed they will most likely be most successful if they are scaled to support the entire region rather than duplicate effort through multiple small scale facilities. The City's landfill, with its robust permitted disposal capacity, robust real estate footprint, in place methane polishing plant, and close proximity to waste generators, is positioned well to be a key part of a regional solution to these waste handling changes.

Staff proposes to activate several initiatives in light of the above-described circumstances:

1. Conduct feasibility analysis regarding organic waste processing technologies to be sited at the landfill

2. Conduct feasibility analysis regarding expanding the existing yard waste composting operation to support a regional need

3. Evaluate a proposal to receive regionally generated MSW at the Richland landfill

All of these initiatives will generate analysis of the costs, benefits, and risks associated with the options available to the City. Staff will engage with the Utility Advisory Committee to establish the scope of these analyses and to review and consider the findings.

Fiscal Impact:

Attachments:

1. HRL Exp Life TechMemo 06222023 - Final
2. Organics Collection and Processing - UAC - 5-09-2023
3. Landfill Planning - Regional Services - UAC - 9-12-2023

TECHNICAL MEMORANDUM

DATE: June 22, 2023
TO: Pete Rogalsky, PE
FROM: Tiffany Neier, PE
Dwight Miller, PE
SUBJECT: Landfill Expansion Projection
CC: Mark Chidester
PROJECT NUMBER: 555-3820-004
PROJECT NAME: Horn Rapids Landfill Expansion

INTRODUCTION

The City of Richland (City) owns the Horn Rapids Landfill (HRL), which is located at 3102 Twin Bridges Road, Richland, Washington 99352, and is currently permitted for disposal of municipal solid waste (MSW). Recorded waste tonnages received by HRL in the last 10 years have significantly outpaced previous waste projections. As a result, the City is evaluating the capacity and site life of HRL based upon expansion within the current parcel. The purpose of this memorandum is to summarize the revised phasing plan and site life projections derived from recent waste records and a sensitivity analysis of factors including waste disposal rate increase, compaction density, organic material diversion, and expansion of service area.

The parcel on which the Old and New landfills are located is bounded by Twin Bridges Road on the west, Horn Rapids Road on the north, and State Route 240 on the south with a footprint of 290 acres (Attachment 1). The Old Landfill encompasses approximately 53 acres with the final cover installed and the New Landfill is permitted for 104 acres of MSW (Attachment 2). This memorandum includes a potential Northwest Expansion with an additional 66 acres of areal extent.

FUTURE EXPANSION PROJECTIONS

The projected capacity for the permitted New Landfill expansion phases has been updated for the analysis to reflect the most recently proposed surfaces that include a modified top deck as seen in Attachment 2. The site life projections have been re-evaluated several times between 2012 and 2017. Actual recorded waste tonnages received by HRL have outpaced all the previous estimates. Figure 1 shows the recorded waste tonnages from 2008 to 2022. The decline in 2008 to 2012 may correspond to an economic recession in the United States while the sharp decrease in 2012 is likely an impact of the City initiating a curbside yard waste collection and diversion program, as well as curbside recycling services (in addition to the City's drop box program). The sharp spike in 2022 is potentially impacted by an increase of consumer spending (increasing waste generation per capita), and increased number of building projects as the Tri-Cities emerged from the Covid-19 pandemic. Many other factors can contribute to this increase in refuse. The years 2014 through 2021 were used to calculate an annual waste generation rate increase of 5.19%, which was the highest rate evaluated.

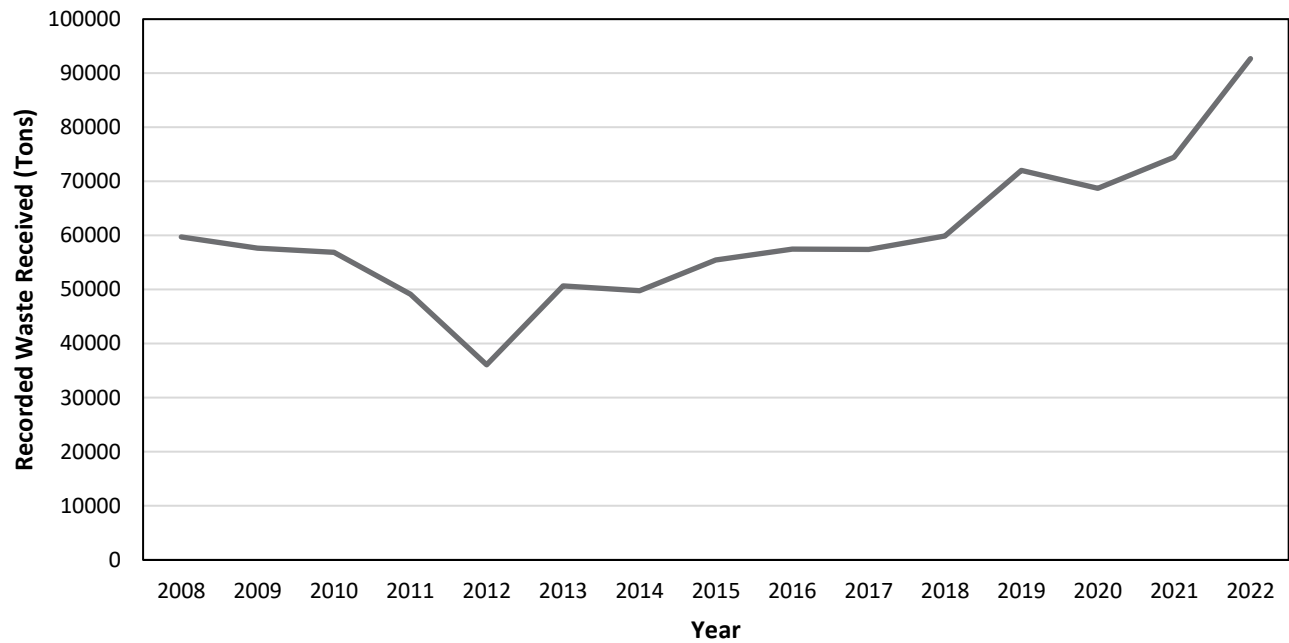


Figure 1 – Recorded MSW tonnages received at Horn Rapids Landfill

EXPANSION SITE LIFE ANALYSIS

Phase Volume Analysis

The start of the analysis used the phases outlined in the Municipal Solid Waste Expansion Construction Permit for the Horn Rapids MSW Landfill Expansion (2017 permitted landfill expansion), approved on November 13, 2017. An initial site life analysis based on the updated recorded waste values for 2020-2022 showed that Phases 2, 3, 7, and 8 of the 2017 permitted landfill expansion were unable to provide sufficient capacity as separate units. Therefore, Phases 2 and 3 were combined into Phase 2, and Phases 7 and 8 were combined into Phase 6 for all further analyses of site life. The updated volumes for each phase are shown in Table 1, and an updated site plan is included in Appendix B.

Table 1. Horn Rapids Landfill Revised Phasing Plan

Landfill Phase	Capacity (cy) ¹
Phase 1	1,114,000
Phase 2	2,356,000
Phase 3	1,960,000
Phase 4	3,619,000
Phase 5	2,699,000
Phase 6	2,974,000
Northwest Expansion	10,543,000
Total	25,265,000

1. Capacity rounded to the nearest 1000 cubic yards.

The total capacity for the Northwest Expansion is included in Table 1. The Northwest Expansion was conceptually graded in AutoCAD Civil3D with the following assumptions:

- The expansion has a 150-foot buffer from the property line to the north.
- Overfills onto the permitted New Landfill on the east.
- Fill to the property line on the west (150 feet on the City parcel to the west will need to be dedicated as buffer).
- The existing flare station to the south will be preserved.
- Future leachate pond west of the existing flare station

Sensitivity Analysis

Parametrix performed a sensitivity analysis to evaluate the impact of waste generation rate, compaction, organics diversion, and service area expansion on the site life of the full landfill expansion (Phases 1-6 and Northwest Expansion). In total, eight scenarios were reviewed with different combinations of the sensitivity parameters defined below. Complete sensitivity analysis calculations for landfill site life are provided in Appendix A.

Sensitivity Parameters

Waste Generation Rate

Estimations for increases in waste generation rates are typically based on historic trends in recorded waste and region-specific population growth projections. Because these factors can vary, three levels of waste generation rates were assessed to account for the uncertainty associated with estimation methods as follows:

- **Low:** A low rate of 1.12% was assumed based the Office of Financial Management's (OFM) 2022 Growth Management Act (GMA) Middle Series Population Projections for Benton County.
- **Medium:** A medium rate of 2.00% was assumed based on the *Solid Waste Disposal Alternatives Analysis report* (Parametrix. 2013).
- **High:** A high filling rate of 5.19% was calculated from HRL's annual recorded waste rates for 2014-2021 as described previously. This time period appeared to have the steadiest increase and was not part of the 2008 recession or 2022 building boom coming out of the Covid-19 pandemic.

Refuse Compaction

In previous site life analyses conducted for HRL, compacted density of refuse was assumed to be 1,200 lb/cy; however, current standard practices may result in increased compaction densities. Accordingly, site life was evaluated with the following two compaction densities:

- 1,200 lb/cy
- 1,500 lb/cy

Organics Diversion

Recently passed in 2022, Washington State's House Bill 1799 (HB 1799) established a statewide goal to reduce landfill disposal of organic materials by 75% compared to 2015 disposal levels. Green waste is currently sent to a composting area so the diversion of other organics may have a small impact on the volume of MSW going to the landfill. Therefore, for all scenarios, Parametrix assumed that 2% of the total annual recorded waste (by volume)

represented organic materials that were diverted from landfill disposal. A 10% organics diversion rate was also evaluated for the low rate of refuse increase with 1,500lb/cy compaction (longest landfill lifespan), and the high rate of refuse increase with 1,200 lb/cy compaction (shortest landfill lifespan). There was only an additional 2 to 5 years of life added to the site. These results are not included in the tables below, but the calculations are provided in Attachment 3.

Service Area Expansion

The potential for service area expansion to other areas in Benton and Franklin counties was also evaluated. The medium-level growth scenarios were evaluated with an 80,000-ton waste addition in the year 2026. Following 2026, annual growth rates were applied to the entire expanded service area.

Sensitivity Results

Results of the sensitivity analysis are tabulated in Tables 2 and 3 and illustrated in Figure 2.

Table 2. Site Life Sensitivity Analysis Results Reported by Phase Opening Year

Scenario	Low		Medium		High		Medium with Additional Waste in 2026	
Growth Rate	1.12%		2.00%		5.19%		2.00%	
Waste Density (lb/cy)	1200	1500	1200	1500	1200	1500	1200	1500
Phase Opening Year								
Phase 1	2020	2020	2020	2020	2020	2020	2020	2020
Phase 2	2028	2029	2027	2029	2027	2028	2026	2027
Phase 3	2043	2048	2041	2045	2037	2040	2034	2036
Phase 4	2053	2060	2050	2055	2043	2046	2039	2043
Phase 5	2070	2080	2063	2070	2050	2054	2048	2053
Phase 6	2081	2092	2071	2079	2054	2058	2054	2059
Northwest Expansion	2092	2104	2079	2087	2058	2062	2059	2065
Final Closure Year								
	2122	2136	2099	2108	2067	2072	2075	2083

Table 3. Site Life Sensitivity Analysis Results Reported as Total Phase Lifespan

Scenario	Low		Medium		High		Medium with Additional Waste in 2026	
Growth Rate	1.12%		2.00%		5.19%		2.00%	
Waste Density (lb/cy)	1200	1500	1200	1500	1200	1500	1200	1500
Phase Lifespan (Years)								
Phase 1	8	9	7	9	7	8	6	7
Phase 2	15	19	14	16	10	12	8	9
Phase 3	10	12	9	10	6	6	5	7
Phase 4	17	20	13	15	7	8	9	10
Phase 5	11	12	8	9	4	4	6	6
Phase 6	11	12	8	8	4	4	5	6
Northwest Expansion	30	32	20	21	9	10	16	18
Final Closure (Years)								
	102	116	79	88	47	52	55	63

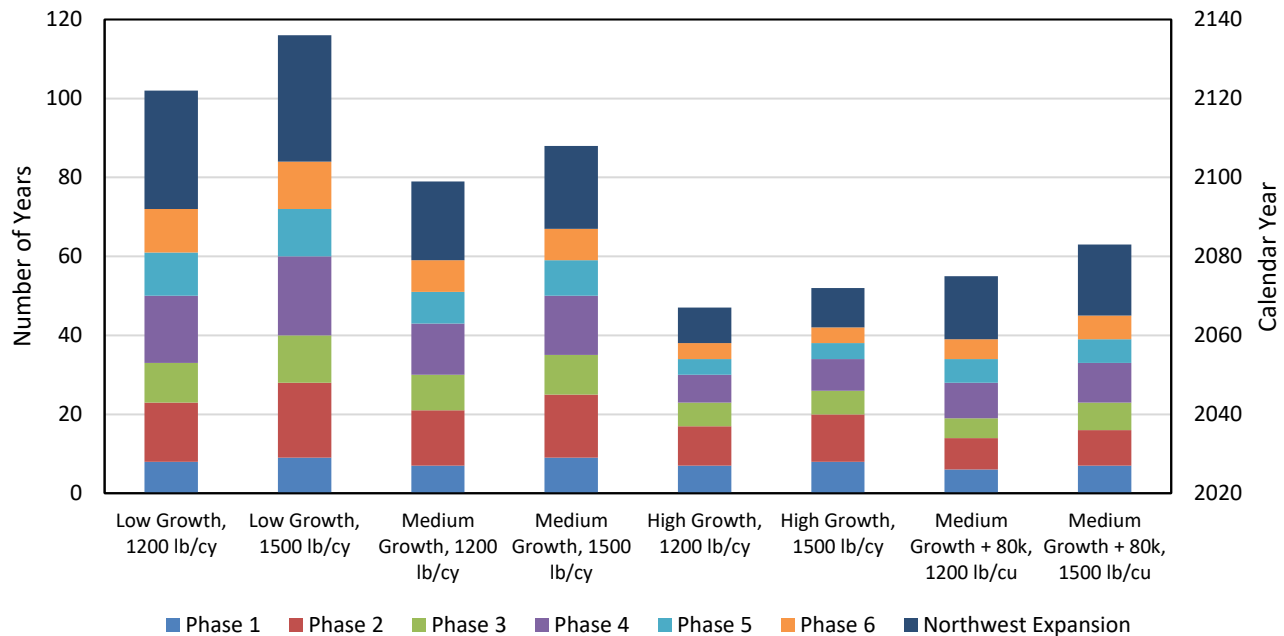


Figure 2 – Site life sensitivity analysis results

CONCLUSIONS

This analysis demonstrated the impact that compaction, organics diversion, and growth rate have on the number of years the Horn Rapids Landfill has the capacity to accommodate. Assumed growth rates have the largest impact on the estimated life of a planned cell. Based on this analysis, the lowest growth rate provides a lifespan

64 years longer than the assumed highest rate of increase (Table 3). The actual rate of refuse increase is likely to fluctuate between these two growth rates as refuse quantities are impacted by local and global factors like economic recessions and housing booms (Figure 1). Increased compaction can also add 5 to 14 years of filling using the expanded Northwest Expansion area (Table 3). Organics diversion may have a limited impact on accumulated waste volume; 10% diversion adds an additional 2-5 years to total site life (Attachment 3).

A Northwest Expansion, as shown in Attachments 1 and 3, is estimated to provide an additional 10.5 million cubic yards of capacity (Table 1). This expansion extends the lifespan of the fill area by 20 years (Table 3) assuming the medium growth rate, 1,200lb/cy compaction and 2% organics diversion. This scenario projects that the landfill will reach maximum capacity in 2099 (Table 2).

Current filling rates, which are modeled as a high rate of increase, indicate that Phase 1 will reach maximum capacity around 2027. Even with a reduced rate of increase to 2%, the landfill is projected to reach capacity in 2027.

Previous records have defined the HRL parcel area as 275 acres. However, as seen in Attachment 4, a boundary survey conducted in 2010 shows that the actual parcel area is 289.5 acres, consistent with the 290 acres measured in Parametrix's analysis. All records should be corrected to reflect actual surveyed acreage.

ATTACHMENTS

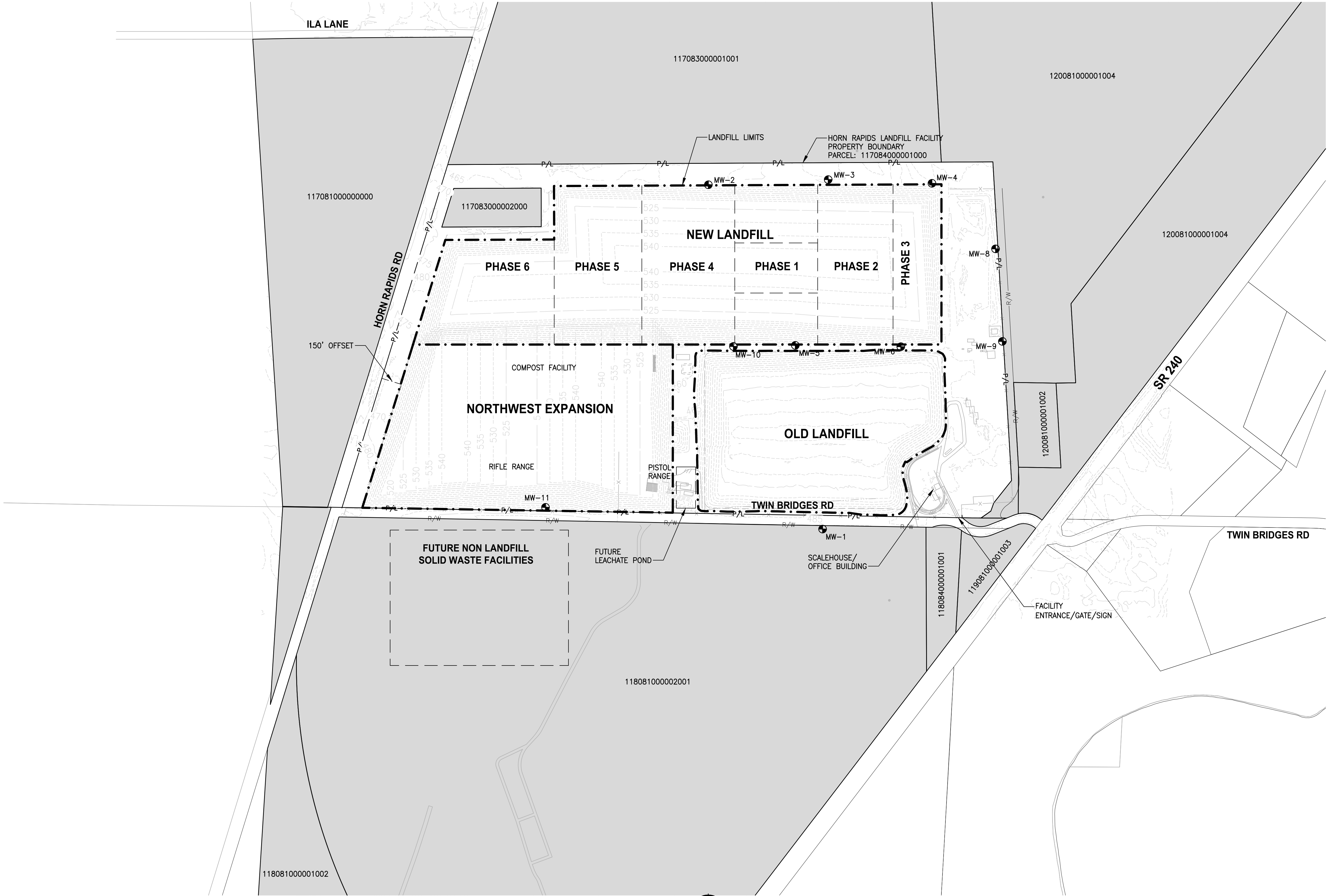
1. Landfill Phase Layout
2. Landfill Expansion Acreage
3. Projected Site Life
4. Landfill Record of Survey

Attachment 1

Landfill Phase Layout



LAYOUT: C4 PATH: \\parametrix.com\pm\PSO\Projects\Clients\3820-City of Richland\555-3820-004 HornRapids201EM\995vcs\CADD\555-3820-004 Phase 13 2023\PDF figure\ PLOTTED BY: NeerTir DATE: Tuesday, May 23, 2023 2:26:01 PM



- LEGEND:**
- WATER SUPPLY WELL LOCATION
 - ⊙ GROUNDWATER MONITORING WELL LOCATION
 - P/L — PROPERTY BOUNDARY
 - · - · - LANDFILL LIMITS
 - — — PHASES DEVELOPMENT BOUNDARY

NAMES AND ADDRESSES OF CONTIGUOUS PROPERTY OWNERS

PARCEL NO.	NAME AND ADDRESS
118081000002001	CITY OF RICHLAND POB 190. RICHLAND, WA, 99352-0190
117081000000000	BLM
117083000002000	KURION, INC. 2040 MAIN ST. SUITE 800 IRVINE, CA 92614
117083000001001	CITY OF RICHLAND POB 190. RICHLAND, WA, 99352-0190
120081000001004	CITY OF RICHLAND POB 190. RICHLAND, WA, 99352-0191
120081000001002	BENEFICIAL REUSE SOLUTIONS, LLC. 2990 TWIN BRIDGES RD. RICHLAND, WA 99354
118084000001001	STANGGELAND LOREN & VIVIAN 102 HILLVIEW DR. RICHLAND, WA 99352-9668
119081000001003	STANGGELAND LOREN & VIVIAN 102 HILLVIEW DR. RICHLAND, WA 99352-9669
118081000001002	WASHINGTON STATE UNIV. POB 641045 PULLMANN, WA 99164-1045



REVISIONS	DATE	BY	DESIGNED
			T. NEIER
			DRAWN
			B. ANTOINE
			CHECKED
			APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
FILE NAME Future Expansion Site Map Updated
JOB No. 555-3820-004 P13
DATE MAY 2023

PRELIMINARY

Parametrix
ENGINEERING · PLANNING · ENVIRONMENTAL SCIENCES

719 2ND AVENUE, SUITE 200 | SEATTLE, WA 98104
P 206.394.3700
WWW.PARAMETRIX.COM

PROJECT NAME
HORN RAPIDS LANDFILL EXPANSION
RICHLAND, WA

LANDFILL PHASE LAYOUT

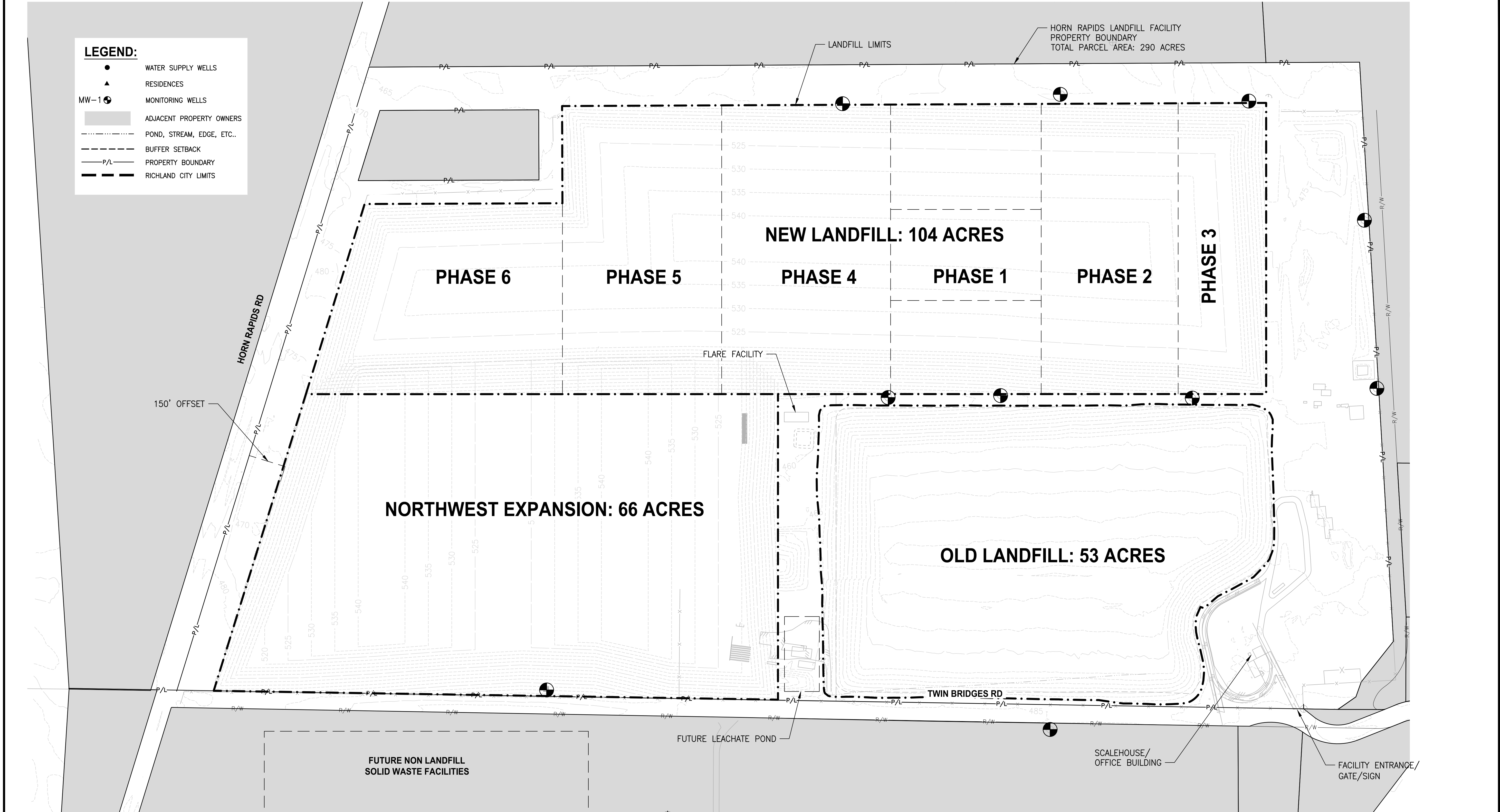
DRAWING NO. 1 OF 2
1

Attachment 2

Landfill Expansion Acreage



LAYOUT: C5 PATH: \\parametrix.com\pmx\PSO\Projects\Clients\3820-City of Richland\555-3820-004 HornRapids2011EM\995vcs\CADD\555-3820-004 Phase 13 2023\PDF figure\ PLOTTED BY: NaderTir DATE: Tuesday, May 23, 2023 2:24:43 PM



REVISIONS	DATE	BY	DESIGNED
			T.NEIER
			DRAWN
			B.ANTOINE
			CHECKED
			APPROVED

ONE INCH AT FULL SCALE.
IF NOT, SCALE ACCORDINGLY

FILE NAME
Future Expansion Site Map Updated

JOB No.
555-3820-004 P13

DATE
MAY 2023

PRELIMINARY

Parametrix
ENGINEERING · PLANNING · ENVIRONMENTAL SCIENCES

719 2ND AVENUE, SUITE 200 | SEATTLE, WA 98104
P 206.394.3700
WWW.PARAMETRIX.COM

PROJECT NAME
HORN RAPIDS LANDFILL EXPANSION

RICHLAND, WA

**LANDFILL EXPANSION
ACREAGE**

DRAWING NO.
2 OF 2

2

Attachment 3

Projected Site Life



Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
1.12%	1,200	10%	0	0	2%

Low Rate Increase - 1,200lb/cy Compaction

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)								
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total	
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282	
2020	51,541	12,756	64,297	85,901	8,590		94,491	51,541	64,297	94,491	25,170,791	Phase 1	1,019,654							2020-2028	
2021	74,462	18,429	92,891	124,103	12,410		136,514	74,462	92,891	231,005	25,034,277		883,140								
2022	92,699	22,943	115,642	154,498	15,450		169,948	92,699	115,642	400,953	24,864,329	427,915	713,192								
2023	76,129	18,842	94,971	126,882	12,688		139,570	168,828	210,613	540,523	24,724,759		573,622								
2024	76,981	19,053	96,034	128,302	12,830	2,566	138,566	245,809	306,647	679,090	24,586,192		435,055								
2025	77,843	19,266	97,109	129,738	12,974	2,595	140,118	323,653	403,757	819,207	24,446,075		294,938								
2026	78,715	19,482	98,196	131,191	13,119	2,624	141,686	402,367	501,953	960,893	24,304,389		153,252								
2027	79,596	19,700	99,296	132,659	13,266	2,653	143,272	481,963	601,248	1,104,166	24,161,116		9,979								
2028	80,487	19,920	100,407	134,144	13,414	2,683	144,876	562,449	701,656	1,249,042	24,016,240	Phase 2	-134,897	2,220,773					2028-2043		
2029	81,388	20,143	101,531	135,646	13,565	2,713	146,498	643,837	803,187	1,395,539	23,869,743			2,074,276							
2030	82,299	20,369	102,668	137,165	13,716	2,743	148,138	726,136	905,855	1,543,677	23,721,605			1,926,138							
2031	83,220	20,597	103,817	138,700	13,870	2,774	149,796	809,356	1,009,672	1,693,473	23,571,809			1,776,342							
2032	84,152	20,828	104,979	140,253	14,025	2,805	151,473	893,508	1,114,651	1,844,946	23,420,336			1,624,869							
2033	85,094	21,061	106,154	141,823	14,182	2,836	153,169	978,601	1,220,805	1,998,115	23,267,167			1,471,700							
2034	86,046	21,296	107,343	143,410	14,341	2,868	154,883	1,064,648	1,328,148	2,152,998	23,112,284			1,316,817							
2035	87,010	21,535	108,544	145,016	14,502	2,900	156,617	1,151,657	1,436,692	2,309,615	22,955,667			1,160,200							
2036	87,984	21,776	109,759	146,639	14,664	2,933	158,370	1,239,641	1,546,452	2,467,986	22,797,296			1,001,829							
2037	88,968	22,020	110,988	148,281	14,828	2,966	160,143	1,328,609	1,657,440	2,628,129	22,637,153			841,686							
2038	89,964	22,266	112,231	149,941	14,994	2,999	161,936	1,418,573	1,769,670	2,790,065	22,475,217			679,750							
2039	90,971	22,515	113,487	151,619	15,162	3,032	163,749	1,509,545	1,883,157	2,953,814	22,311,468			516,001							
2040	91,990	22,767	114,757	153,316	15,332	3,066	165,582	1,601,535	1,997,915	3,119,395	22,145,887			350,420							
2041	93,020	23,022	116,042	155,033	15,503	3,101	167,435	1,694,554	2,113,957	3,286,831	21,978,451			182,984							
2042	94,061	23,280	117,341	156,768	15,677	3,135	169,310	1,788,615	2,231,298	3,456,140	21,809,142			13,675							
2043	95,114	23,541	118,655	158,523	15,823	3,170	171,205	1,883,729	2,349,952	3,627,345	21,637,937	Phase 3	-157,530	1,802,290				2043-2053			
2044	96,179	23,804	119,983	160,298	16,030	3,206	173,122	1,979,908	2,469,935	3,800,467	21,464,815			1,629,168							
2045	97,255	24,071	121,326	162,092	16,209	3,242	175,060	2,077,163	2,591,261	3,975,527	21,289,755			1,454,108							
2046	98,344	24,340	122,684	163,907	16,391	3,278	177,019	2,175,507	2,713,945	4,152,546	21,112,736			1,277,089							
2047	99,445	24,613	124,058	165,742	16,574	3,315	179,001	2,274,952	2,838,003	4,331,547	20,933,735			1,098,088							
2048	100,558	24,888	125,446	167,597	16,760	3,352	181,005	2,375,510	2,963,449	4,512,551	20,752,731			917,084							
2049	101,684	25,167	126,851	169,473	16,947	3,389	183,031	2,477,194	3,090,300	4,695,582	20,569,700			734,053							
2050	102,822	25,448	128,271	171,370	17,137	3,427	185,080	2,580,016	3,218,570	4,880,662	20,384,620			548,973							
2051	103,973	25,733	129,707	173,289	17,329	3,466	187,152	2,683,990	3,348,277	5,067,814	20,197,468			361,821							
2052	105,137	26,021	131,159	175,228	17,523	3,505	189,247	2,789,127	3,479,435	5,257,061	20,008,221			172,574							
2053	106,314	26,313	132,627	177,190	17,719	3,544	191,365	2,895,441	3,612,062	5,448,426	19,816,856	Phase 4	-18,791	3,600,508				2053-2070			
2054	107,504	26,607	134,111	179,174	17,917	3,583	193,507	3,002,945	3,746,174	5,641,933	19,623,349			3,407,001							
2055	108,708	26,905	135,613	181,179	18,118	3,624	195,674	3,111,652	3,881,786	5,837,607	19,427,675			3,211,327							
2056	109,925	27,206	137,131	183,208	18,321	3,664	197,864	3,221,577	4,018,917	6,035,471	19,229,811			3,013,463							
2057	111,155	27,511	138,666	185,258	18,526	3,705	200,079	3,332,732	4,157,583	6,235,550	19,029,732			2,813,384							
2058	112,399	27,819	140,218	187,332	18,733	3,747	202,319	3,445,131	4,297,801	6,437,869	18,827,413			2,611,065							
2059	113,658	28,130	141,788	189,429	18,943	3,789	204,584	3,558,789	4,439,589	6,642,453	18,622,829			2,406,481							
2060	114,930	28,445	143,375	191,550	19,155	3,831	206,874	3,673,719	4,582,964	6,849,327	18,415,955			2,199,607							
2061	116,217	28,764	144,980	193,694	19,369	3,874	209,190	3,789,935	4,727,944	7,058,516	18,206,766			1,990,418							
2062	117,517	29,086	146,603	195,862	19,586	3,917	211,531	3,907,453	4,874,547	7,270,048	17,995,234			1,778,886							
2063	118,833	29,411	148,244	198,055	19,806	3,961	213,899	4,026,286	5,022,792	7,483,947	17,781,335			1,564,987							
2064	120,163	29,740	149,904	200,272	20,027	4,005	216,294	4,146,449	5,172,695	7,700,241	17,565,041			1,348,693							
2065	121,508	30,073	151,582	202,514	20,251	4,050	218,715	4,267,958	5,324,277	7,918,956	17,346,326			1,129,978							
2066	122,869	30,410	153,279	204,781	20,478	4,096	221,164	4,390,826	5,477,556	8,140,120	17,125,162			908,814							
2067	124,244	30,750	154,995	207,074	20,707	4,141	223,639	4,515,070	5,632,550	8,363,759	16,901,523			685,175							
2068	125,635	31,095	156,730	209,392	20,939	4,188	226,143	4,640,705	5,789,280	8,589,902	16,675,380			459,032							
2069	127,041	31,443	158,484	211,736	21,174	4,235	228,674	4,767,747	5,947,764	8,818,577	16,446,705			230,357							
2070	128,464	31,795	160,258	214,106	21,411	4,282	231,234	4,896,210	6,108,022	9,049,811	16,215,471	Phase 5	-877	2,697,948				2070-2081			
2071	129,902	32,151	162,052	216,503	21,650	4,330	233,823	5,026,112	6,270,075	9,283,634	15,981,648			2,464,125							
2072	131,356	32,511	163,866	218,926	21,893	4,379	236,440	5,157,468	6,433,941	9,520,074	15,745,208			2,227,685							
2073	132,826	32,874	165,701	221,377	22,138	4,428	239,087	5,290,294	6,599,642	9,759,162	15,506,120			1,988,597							
2074	134,313	33,242	167,556	223,855	22,386	4,477	241,764	5,424,607	6,767,197	10,000,925	15,264,357			1,746,834							
2075	135,817	33,615	169,431	226,361	22,636	4,527	244,470	5,560,424	6,936,628	10,245,395	15,019,887			1,502,364							
2076	137,337	33,991	171,328	228,895	22,890	4,578	247,207	5,697,761	7,107,956	10,492,602	14,772,680			1,255,157							
2077	138,874	34,371	173,246	231,457	23,146	4,629	249,974	5,836,635	7,281,202	10,742,576	14,522,706			1,005,183							
2078	140,429	34,756	175,185	234,048	23,405	4,681	252,772	5,977,064	7,456,388	10,995,348	14,269,934			752,411							
2079	142,001	35,145	177,146	236,669	23,667	4,733	255,602	6,119,065	7,633,534	11,250,950	14,014,332			496,809							
2080	143,591	35,539	179,129	239,318	23,932																

**Projected Site Life
Horn Rapids Landfill Expansion**

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)							
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2099	177,413	43,910	221,322	295,688	29,569	5,914	319,343	9,317,814	11,623,972	17,008,697	8,256,585								8,256,585	
2100	179,399	44,401	223,800	298,998	29,900	5,980	322,918	9,497,212	11,847,772	17,331,615	7,933,667								7,933,667	
2101	181,407	44,898	226,305	302,345	30,235	6,047	326,533	9,678,619	12,074,078	17,658,148	7,607,134								7,607,134	
2102	183,438	45,401	228,839	305,730	30,573	6,115	330,188	9,862,057	12,302,917	17,988,336	7,276,946								7,276,946	
2103	185,491	45,909	231,400	309,152	30,915	6,183	333,884	10,047,549	12,534,317	18,322,220	6,943,062								6,943,062	
2104	187,568	46,423	233,991	312,613	31,261	6,252	337,622	10,235,116	12,768,308	18,659,842	6,605,440								6,605,440	
2105	189,667	46,943	236,610	316,112	31,611	6,322	341,401	10,424,784	13,004,918	19,001,244	6,264,038								6,264,038	
2106	191,791	47,468	239,259	319,651	31,965	6,393	345,223	10,616,575	13,244,177	19,346,467	5,918,815								5,918,815	
2107	193,938	48,000	241,937	323,229	32,323	6,465	349,088	10,810,512	13,486,114	19,695,555	5,569,727								5,569,727	
2108	196,109	48,537	244,646	326,848	32,685	6,537	352,996	11,006,621	13,730,760	20,048,550	5,216,732								5,216,732	
2109	198,304	49,080	247,384	330,507	33,051	6,610	356,947	11,204,925	13,978,144	20,405,498	4,859,784								4,859,784	
2110	200,524	49,630	250,154	334,207	33,421	6,684	360,943	11,405,449	14,228,298	20,766,441	4,498,841								4,498,841	
2111	202,769	50,185	252,954	337,948	33,795	6,759	364,984	11,608,218	14,481,251	21,131,424	4,133,858								4,133,858	
2112	205,039	50,747	255,786	341,731	34,173	6,835	369,069	11,813,256	14,737,037	21,500,494	3,764,788								3,764,788	
2113	207,334	51,315	258,649	345,556	34,556	6,911	373,201	12,020,590	14,995,686	21,873,695	3,391,587								3,391,587	
2114	209,655	51,890	261,544	349,425	34,942	6,988	377,379	12,230,245	15,257,230	22,251,073	3,014,209								3,014,209	
2115	212,002	52,470	264,472	353,336	35,334	7,067	381,603	12,442,247	15,521,703	22,632,676	2,632,606								2,632,606	
2116	214,375	53,058	267,433	357,292	35,729	7,146	385,875	12,656,622	15,789,135	23,018,551	2,246,731								2,246,731	
2117	216,775	53,652	270,427	361,291	36,129	7,226	390,195	12,873,396	16,059,562	23,408,746	1,856,536								1,856,536	
2118	219,201	54,252	273,454	365,336	36,534	7,307	394,563	13,092,598	16,333,016	23,803,309	1,461,973								1,461,973	
2119	221,655	54,860	276,515	369,426	36,943	7,389	398,980	13,314,253	16,609,531	24,202,288	1,062,994								1,062,994	
2120	224,137	55,474	279,610	373,561	37,356	7,471	403,446	13,538,390	16,889,141	24,605,734	659,548								659,548	
2121	226,646	56,095	282,740	377,743	37,774	7,555	407,962	13,765,035	17,171,882	25,013,696	251,586								251,586	
2122	229,183	56,723	285,906	381,971	38,197	7,639	412,529	13,994,218	17,457,787	25,426,226	0								-160,944	

Notes:

- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values from OFM 2020-2050 Mid-Growth Projections thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3] Assume soil mass is approximately 10 percent of annual waste volume.
- [4] Total Landfill Mass: [2] + [3].
- [5] Waste volume assuming a density shown in table (lb/cy).
- [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8] Total Landfill Volume: [5] + [6].
- [9] Accumulative waste mass tonnages for the landfill.
- [10] Accumulative total landfill mass in tons.
- [11] Accumulative total landfill volume in cubic yards.
- [12] Remaining capacity.
- [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

**Projected Site Life
Horn Rapids Landfill Expansion**

Waste Yearly Increase	Waste Density (lb/cy) Refuse	Soil Mass by Percent of Waste (Ton)	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
1.12%	1,500	10%	0	0	2%

Low Rate Increase - 1,500lb/cy Compaction

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest	Total
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1						Expansion	
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51,541	10,205	61,746	68,721	6,872		75,593	51,541	61,746	75,593	25,189,689	Phase 1	1,038,552							2020-2029
2021	74,462	14,743	89,205	99,283	9,928		109,211	74,462	89,205	184,804	25,080,478									
2022	92,699	18,354	111,053	123,599	12,360		135,959	92,699	111,053	320,763	24,944,519	595,037	793,382							
2023	76,129	15,074	91,203	101,505	10,151		111,656	168,828	202,256	432,419	24,832,863									
2024	76,981	15,242	92,224	102,642	10,264	2,053	110,853	245,809	294,480	543,272	24,722,010									
2025	77,843	15,413	93,256	103,791	10,379	2,076	112,094	323,653	387,736	655,366	24,609,916									
2026	78,715	15,585	94,300	104,953	10,495	2,099	113,349	402,367	482,036	768,715	24,496,567									
2027	79,596	15,760	95,356	106,128	10,613	2,123	114,618	481,963	577,391	883,332	24,381,950									
2028	80,487	15,936	96,423	107,316	10,732	2,146	115,901	562,449	673,814	999,233	24,266,049									
2029	81,388	16,115	97,502	108,517	10,852	2,170	117,198	643,837	771,317	1,116,432	24,148,850	Phase 2	-2,287	2,353,383					2029-2048	
2030	82,299	16,295	98,594	109,732	10,973	2,195	118,510	726,136	869,911	1,234,942	24,030,340			2,234,873						
2031	83,220	16,478	99,698	110,960	11,096	2,219	119,837	809,356	969,608	1,354,779	23,910,503			2,115,036						
2032	84,152	16,662	100,814	112,202	11,220	2,244	121,178	893,508	1,070,422	1,475,957	23,789,325			1,993,858						
2033	85,094	16,849	101,942	113,458	11,346	2,269	122,535	978,601	1,172,364	1,598,492	23,666,790			1,871,323						
2034	86,046	17,037	103,083	114,728	11,473	2,295	123,907	1,064,648	1,275,448	1,722,399	23,542,883			1,747,416						
2035	87,010	17,228	104,237	116,013	11,601	2,320	125,294	1,151,657	1,379,685	1,847,692	23,417,590			1,622,123						
2036	87,984	17,421	105,404	117,311	11,731	2,346	126,696	1,239,641	1,485,089	1,974,389	23,290,893			1,495,426						
2037	88,968	17,616	106,584	118,625	11,862	2,372	128,115	1,328,609	1,591,674	2,102,503	23,162,779			1,367,312						
2038	89,964	17,813	107,777	119,953	11,995	2,399	129,549	1,418,573	1,699,451	2,232,052	23,033,230			1,237,763						
2039	90,971	18,012	108,984	121,295	12,130	2,426	130,999	1,509,545	1,808,435	2,363,051	22,902,231			1,106,764						
2040	91,990	18,214	110,204	122,653	12,265	2,453	132,465	1,601,535	1,918,639	2,495,516	22,769,766			974,299						
2041	93,020	18,418	111,438	124,026	12,403	2,481	133,948	1,694,554	2,030,076	2,629,465	22,635,817			840,350						
2042	94,061	18,624	112,685	125,415	12,541	2,508	135,448	1,788,615	2,142,761	2,764,912	22,500,370			704,903						
2043	95,114	18,833	113,946	126,819	12,682	2,536	136,964	1,883,729	2,256,708	2,901,876	22,363,406			567,939						
2044	96,179	19,043	115,222	128,238	12,824	2,565	138,497	1,979,908	2,371,930	3,040,374	22,224,908			429,441						
2045	97,255	19,257	116,512	129,674	12,967	2,593	140,048	2,077,163	2,488,442	3,180,421	22,084,861			289,394						
2046	98,344	19,472	117,816	131,125	13,113	2,623	141,615	2,175,507	2,606,258	3,322,037	21,943,245			147,778						
2047	99,445	19,690	119,135	132,593	13,259	2,652	143,201	2,274,952	2,725,393	3,465,237	21,800,045			4,578						
2048	100,558	19,911	120,469	134,078	13,408	2,682	144,804	2,375,510	2,845,861	3,610,041	21,655,241	Phase 3		-140,226	1,819,594				2048-2060	
2049	101,684	20,133	121,817	135,578	13,558	2,712	146,425	2,477,194	2,967,679	3,756,466	21,508,816			1,673,169						
2050	102,822	20,359	123,181	137,096	13,710	2,742	148,064	2,580,016	3,090,860	3,904,530	21,360,752			1,525,105						
2051	103,973	20,587	124,560	138,631	13,863	2,773	149,721	2,683,990	3,215,419	4,054,251	21,211,031			1,375,384						
2052	105,137	20,817	125,954	140,183	14,018	2,804	151,397	2,789,127	3,341,374	4,205,648	21,059,634			1,223,987						
2053	106,314	21,050	127,364	141,752	14,175	2,835	153,092	2,895,441	3,468,738	4,358,741	20,906,541			1,070,894						
2054	107,504	21,286	128,790	143,339	14,334	2,867	154,806	3,002,945	3,597,528	4,513,547	20,751,735			916,088						
2055	108,708	21,524	130,232	144,943	14,494	2,899	156,539	3,111,652	3,727,760	4,670,086	20,595,196			759,549						
2056	109,925	21,765	131,690	146,566	14,657	2,931	158,291	3,221,577	3,859,449	4,828,377	20,436,905			601,258						
2057	111,155	22,009	133,164	148,207	14,821	2,964	160,063	3,332,732	3,992,613	4,988,440	20,276,842			441,195						
2058	112,399	22,255	134,654	149,866	14,987	2,997	161,855	3,445,131	4,127,267	5,150,295	20,114,987			279,340						
2059	113,658	22,504	136,162	151,543	15,154	3,031	163,667	3,558,789	4,263,429	5,313,962	19,951,320			115,673						
2060	114,930	22,756	137,686	153,240	15,324	3,065	165,499	3,673,719	4,401,115	5,479,461	19,785,821	Phase 4		-49,826	3,569,473				2060-2080	
2061	116,217	23,011	139,227	154,955	15,496	3,099	167,352	3,789,935	4,540,343	5,646,813	19,618,469			3,402,121						
2062	117,517	23,268	140,786	156,690	15,669	3,134	169,225	3,907,453	4,681,129	5,816,038	19,449,244			3,232,896						
2063	118,833	23,529	142,362	158,444	15,844	3,169	171,120	4,026,286	4,823,491	5,987,158	19,278,124			3,061,776						
2064	120,163	23,792	143,956	160,218	16,022	3,204	173,035	4,146,449	4,967,446	6,160,193	19,105,089			2,888,741						
2065	121,508	24,059	145,567	162,011	16,201	3,240	174,972	4,267,958	5,113,013	6,335,165	18,930,117			2,713,769						
2066	122,869	24,328	147,197	163,825	16,382	3,276	176,931	4,390,826	5,260,210	6,512,096	18,753,186			2,536,838						
2067	124,244	24,600	148,844	165,659	16,566	3,313	178,912	4,515,070	5,409,054	6,691,008	18,574,274			2,357,926						
2068	125,635	24,876	150,511	167,513	16,751	3,350	180,914	4,640,705	5,559,565	6,871,922	18,393,360			2,177,012						
2																				

**Projected Site Life
Horn Rapids Landfill Expansion**

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)										
2099	177,413	35,128	212,541	236,550	23,655	4,731	255,474	9,317,814	11,162,741	13,806,958	11,658,324		1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	1,115,021	10,543,303	25,265,282
2100	179,399	35,521	214,920	239,198	23,920	4,784	258,334	9,497,212	11,377,660	13,865,292	11,399,990								856,687		
2101	181,407	35,919	217,326	241,876	24,188	4,838	261,226	9,678,619	11,594,986	14,126,518	11,138,764								595,461		
2102	183,438	36,321	219,759	244,584	24,458	4,892	264,150	9,862,057	11,814,745	14,390,669	10,874,613								331,310		
2103	185,491	36,727	222,219	247,322	24,732	4,946	267,107	10,047,549	12,036,963	14,657,776	10,607,506								64,203		
2104	187,568	37,138	224,706	250,090	25,009	5,002	270,098	10,235,116	12,261,669	14,927,874	10,337,408	Northwest Expansion							-205,895	10,337,408	2104-2136
2105	189,667	37,554	227,222	252,890	25,289	5,058	273,121	10,424,784	12,488,891	15,200,995	10,064,287										
2106	191,791	37,975	229,765	255,721	25,572	5,114	276,179	10,616,575	12,718,656	15,477,174	9,788,108										
2107	193,938	38,400	232,337	258,584	25,858	5,172	279,270	10,810,512	12,950,994	15,756,444	9,508,838										
2108	196,109	38,830	234,938	261,478	26,148	5,230	282,397	11,006,621	13,185,932	16,038,840	9,226,442										
2109	198,304	39,264	237,568	264,405	26,441	5,288	285,558	11,204,925	13,423,500	16,324,398	8,940,884										
2110	200,524	39,704	240,228	267,365	26,737	5,347	288,754	11,405,449	13,663,728	16,613,153	8,652,129										
2111	202,769	40,148	242,917	270,358	27,036	5,407	291,987	11,608,218	13,906,645	16,905,139	8,360,143										
2112	205,039	40,598	245,636	273,385	27,338	5,468	295,256	11,813,256	14,152,281	17,200,395	8,064,887										
2113	207,334	41,052	248,386	276,445	27,645	5,529	298,561	12,020,590	14,400,667	17,498,956	7,766,326										
2114	209,655	41,512	251,166	279,540	27,954	5,591	301,903	12,230,245	14,651,833	17,800,859	7,464,423										
2115	212,002	41,976	253,978	282,669	28,267	5,653	305,283	12,442,247	14,905,811	18,106,141	7,159,141										
2116	214,375	42,446	256,821	285,833	28,583	5,717	308,700	12,656,622	15,162,633	18,414,841	6,850,441										
2117	216,775	42,921	259,696	289,033	28,903	5,781	312,156	12,873,396	15,422,329	18,726,997	6,538,285										
2118	219,201	43,402	262,603	292,269	29,227	5,845	315,650	13,092,598	15,684,932	19,042,647	6,222,635										
2119	221,655	43,888	265,543	295,540	29,554	5,911	319,184	13,314,253	15,950,475	19,361,831	5,903,451										
2120	224,137	44,379	268,516	298,849	29,885	5,977	322,757	13,538,390	16,218,991	19,684,587	5,580,695										
2121	226,646	44,876	271,522	302,194	30,219	6,044	326,370	13,765,035	16,490,512	20,010,957	5,254,325										
2122	229,183	45,378	274,561	305,577	30,558	6,112	330,023	13,994,218	16,765,074	20,340,980	4,924,302										
2123	231,748	45,886	277,635	308,998	30,900	6,180	333,718	14,225,967	17,042,708	20,674,698	4,590,584										
2124	234,343	46,400	280,743	312,457	31,246	6,249	337,453	14,460,309	17,323,451	21,012,152	4,253,130										
2125	236,966	46,919	283,885	315,955	31,595	6,319	341,231	14,697,275	17,607,336	21,353,383	3,911,899										
2126	239,619	47,445	287,063	319,492	31,949	6,390	345,051	14,936,894	17,894,399	21,698,434	3,566,848										
2127	242,301	47,976	290,277	323,068	32,307	6,461	348,914	15,179,195	18,184,676	22,047,347	3,217,935										
2128	245,014	48,513	293,526	326,685	32,668	6,534	352,819	15,424,209	18,478,202	22,400,167	2,865,115										
2129	247,756	49,056	296,812	330,342	33,034	6,607	356,769	15,671,965	18,775,014	22,756,936	2,508,346										
2130	250,530	49,605	300,135	334,040	33,404	6,681	360,763	15,922,495	19,075,149	23,117,699	2,147,583										
2131	253,334	50,160	303,495	337,779	33,778	6,756	364,801	16,175,829	19,378,643	23,482,500	1,782,782										
2132	256,170	50,722	306,892	341,560	34,156	6,831	368,885	16,431,999	19,685,535	23,851,385	1,413,897										
2133	259,038	51,290	310,327	345,384	34,538	6,908	373,015	16,691,037	19,995,863	24,224,400	1,040,882										
2134	261,938	51,864	313,801	349,250	34,925	6,985	377,190	16,952,975	20,309,664	24,601,590	663,692										
2135	264,870	52,444	317,314	353,160	35,316	7,063	381,413	17,217,845	20,626,978	24,983,003	282,279										
2136	267,835	53,031	320,866	357,113	35,711	7,142	385,682	17,485,680	20,947,845	25,368,685	0										

Notes:

- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values from OFM 2020-2050 Mid-Growth Projections thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3] Assume soil mass is approximately 10 percent of annual waste volume.
- [4] Total Landfill Mass: [2] + [3].
- [5] Waste volume assuming a density shown in table (lb/cy).
- [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8] Total Landfill Volume: [5] + [6].
- [9] Accumulative waste mass tonnages for the landfill.
- [10] Accumulative total landfill mass in tons.
- [11] Accumulative total landfill volume in cubic yards.
- [12] Remaining capacity.
- [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
2.00%	1,200	10%	0	0	2%

Medium Rate Increase - 1,200lb/cy Compaction

[1]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	Capacity (cy)							
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51,541	12,756	64,297	85,901	8,590		94,491	51,541	64,297	94,491	25,170,791	Phase 1	1,019,654							2020-2027
2021	74,462	18,429	92,891	124,103	12,410		136,514	74,462	92,891	136,514	23,034,277		883,140							
2022	92,699	22,943	115,642	154,498	15,450		169,948	92,699	115,642	169,948	24,864,329	427,915	713,192							
2023	77,440	19,167	96,607	129,067	12,907		141,974	170,139	212,249	212,249	24,722,355		571,218							
2024	78,989	19,550	98,539	131,649	13,165	2,633	142,181	249,129	310,788	310,788	24,580,174		429,037							
2025	80,569	19,941	100,510	134,282	13,428	2,686	145,024	329,698	411,298	411,298	24,435,150		284,013							
2026	82,180	20,340	102,520	136,967	13,697	2,739	147,925	411,878	513,818	513,818	24,287,225		136,088							
2027	83,824	20,746	104,571	139,707	13,971	2,794	150,883	495,702	618,389	618,389	24,136,341	Phase 2		2,340,874					2027-2041	
2028	85,501	21,161	106,662	142,501	14,250	2,850	153,901	581,203	725,051	725,051	23,982,440			2,186,973						
2029	87,211	21,585	108,795	145,351	14,535	2,907	156,979	668,413	833,846	833,846	23,825,461			2,029,994						
2030	88,955	22,016	110,971	148,258	14,826	2,965	160,119	757,368	944,817	944,817	23,665,343			1,869,876						
2031	90,734	22,457	113,190	151,223	15,122	3,024	163,321	848,102	1,058,007	1,058,007	23,502,022			1,706,555						
2032	92,549	22,906	115,454	154,248	15,425	3,085	166,587	940,651	1,173,462	1,173,462	23,335,434			1,539,967						
2033	94,400	23,364	117,763	157,333	15,733	3,147	169,919	1,035,050	1,291,225	1,291,225	23,165,515			1,370,048						
2034	96,288	23,831	120,119	160,479	16,048	3,210	173,318	1,131,338	1,411,344	1,411,344	22,992,198			1,196,731						
2035	98,213	24,308	122,521	163,689	16,369	3,274	176,784	1,229,551	1,533,865	1,533,865	22,815,414			1,019,947						
2036	100,178	24,794	124,971	166,963	16,696	3,339	180,320	1,329,728	1,658,836	1,658,836	22,635,094			839,627						
2037	102,181	25,290	127,471	170,302	17,030	3,406	183,926	1,431,910	1,786,307	1,786,307	22,451,169			655,702						
2038	104,225	25,796	130,020	173,708	17,371	3,474	187,604	1,536,134	1,916,327	1,916,327	22,263,564			468,097						
2039	106,309	26,312	132,621	177,182	17,718	3,544	191,357	1,642,443	2,048,948	2,048,948	22,072,208			276,741						
2040	108,435	26,838	135,273	180,726	18,073	3,615	195,184	1,750,879	2,184,221	2,184,221	21,877,024			81,557						
2041	110,604	27,375	137,979	184,340	18,434	3,687	199,087	1,861,483	2,322,200	2,322,200	21,677,937	Phase 3		-117,530	1,842,290				2041-2050	
2042	112,816	27,922	140,738	188,027	18,803	3,761	203,069	1,974,299	2,462,938	2,462,938	21,474,867				1,639,220					
2043	115,072	28,480	143,553	191,787	19,179	3,836	207,130	2,089,371	2,606,491	2,606,491	21,267,737				1,432,090					
2044	117,374	29,050	146,424	195,623	19,562	3,912	211,273	2,206,745	2,752,915	2,752,915	21,056,464				1,220,817					
2045	119,721	29,631	149,352	199,536	19,954	3,991	215,499	2,326,467	2,902,267	2,902,267	20,840,965				1,005,318					
2046	122,116	30,224	152,340	203,526	20,353	4,071	219,809	2,448,583	3,054,607	3,054,607	20,621,157				785,510					
2047	124,558	30,828	155,386	207,597	20,760	4,152	224,205	2,573,141	3,209,993	3,209,993	20,396,952				561,305					
2048	127,049	31,445	158,494	211,749	21,175	4,235	228,689	2,700,190	3,368,487	3,368,487	20,168,263				332,616					
2049	129,590	32,074	161,664	215,984	21,598	4,320	233,263	2,829,780	3,530,151	3,530,281	19,935,001				99,354					
2050	132,182	32,715	164,897	220,304	22,030	4,406	237,928	2,961,963	3,695,048	3,695,048	19,709,073	Phase 4		-138,574	3,480,725				2050-2063	
2051	134,826	33,369	168,195	224,710	22,471	4,494	242,686	3,096,788	3,863,243	3,863,243	19,454,387				3,238,039					
2052	137,522	34,037	171,559	229,204	22,920	4,584	247,540	3,234,311	4,034,802	4,034,802	19,206,847				2,990,499					
2053	140,273	34,717	174,990	233,788	23,379	4,676	252,491	3,374,583	4,209,793	4,209,793	18,954,356				2,738,008					
2054	143,078	35,412	178,490	238,464	23,846	4,769	257,541	3,517,661	4,388,283	4,388,283	18,696,815				2,480,467					
2055	145,940	36,120	182,060	243,233	24,323	4,865	262,692	3,663,601	4,570,342	4,570,342	18,434,124				2,217,776					
2056	148,859	36,842	185,701	248,098	24,810	4,962	267,945	3,812,460	4,756,043	4,756,043	18,166,178				1,949,830					
2057	151,836	37,579	189,415	253,059	25,306	5,061	273,304	3,964,295	4,945,458	4,945,458	17,892,874				1,676,526					
2058	154,872	38,331	193,203	258,121	25,812	5,162	278,770	4,119,168	5,138,662	5,138,662	17,614,104				1,397,756					
2059	157,970	39,098	197,067	263,283	26,328	5,266	284,346	4,277,138	5,335,729	5,335,729	17,329,758				1,113,410					
2060	161,129	39,879	201,009	268,549	26,855	5,371	290,033	4,438,267	5,536,738	5,536,738	17,039,725				823,377					
2061	164,352	40,677	205,029	273,920	27,392	5,478	295,833	4,602,619	5,741,767	5,741,767	16,743,892				527,544					
2062	167,639	41,491	209,129	279,398	27,940	5,588	301,750	4,770,258	5,950,896	5,950,896	16,442,142				225,794					
2063	170,992	42,320	213,312	284,986	28,499	5,700	307,785	4,941,249	6,164,208	6,164,208	16,134,357	Phase 5				-81,991	2,616,834		2063-2071	
2064	174,411	43,167	217,578	290,686	29,069	5,814	313,941	5,115,661	6,381,787	6,381,787	15,820,416				2,302,893					
2065	177,900	44,030	221,930	296,500	29,650	5,930	320,219	5,293,560	6,603,717	6,603,717	15,500,197				1,982,674					
2066	181,458	44,911	226,368	302,430	30,243	6,049	326,624	5,475,018	6,830,085	6,830,085	15,173,573				1,656,050					
2067	185,087	45,809	230,896	308,478	30,848	6,170	333,156	5,660,105	7,060,981	7,060,981	14,840,417				1,322,894					
2068	188,789	46,725	235,514	314,648	31,465	6,293	339,819	5,848,894	7,296,495	7,296,495	14,500,597				983,074					
2069	192,564	47,660	240,224	320,941	32,094	6,419	346,616	6,041,458	7,536,719	7,536,719	14,153,981				636,458					
2070	196,416	48,613	245,029	327,359	32,736	6,547	353,548	6,237,874	7,781,747	7,781,747	13,800,433				282,910					
2071	200,344	49,585	249,929	333,907	33,391	6,678	360,619	6,438,218	8,031,676	8,031,676	13,439,814	Phase 6				-77,709	2,896,511		2071-2079	
2072	204,351	50,577	254,928	340,585	34,058	6,812	367,832	6,642,568	8,286,604	8,286,604	13,071,982				2,528,679					
2073	208,438	51,588	260,026	347,396	34,740	6,948	375,188	6,851,006	8,546,630	8,546,630	12,696,794				2,153,491					
2074	212,607	52,620	265,227	354,344	35,434	7,087	382,692	7,063,613	8,811,857	8,811,857	12,314,102				1,770,799					
2075	216,859	53,673	270,531	361,431	36,143	7,229	390,346	7,280,472	9,082,388	9,082,388	11,923,757				1,380,454					
2076	221,196	54,746	275,942	368,660	36,866	7,373	398,153	7,501,668	9,358,330	9,358,330	11,525,604				982,301					
2077	225,620	55,841	281,461	376,033	37,603	7,521	406,116	7,727,287	9,639,791	9,639,791	11,119,488				576,185					
2078	230,132	56,958	287,090	383,554	38,355	7,671	414,238	7,957,420	9,926,881	9,926,881	10,705,250				161,947					
2079	234,735	58,097	292,832	391,225	39,122	7,824	422,523	8,192,155	10,219,713	10,219,713	10,282,727	Northwest Expansion				-260,576	10,282,727	2079-2099		
2080	239,4																			

Projected Site Life
Horn Rapids Landfill Expansion

[1]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	Capacity (cy)							
	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
Year													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2099	348,804	86,329	435,133	581,340	58,134	11,627	627,847	14,009,664	17,477,056	25,454,072	0									-188,790

- Notes:
- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
 - [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes a 2% annual increase per the City of Richland, 12-12-2012 thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
 - [3] Assume soil mass is approximately 10 percent of annual waste volume.
 - [4] Total Landfill Mass: [2] + [3].
 - [5] Waste volume assuming a density shown in table (lb/cy).
 - [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
 - [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
 - [8] Total Landfill Volume: [5] + [6].
 - [9] Accumulative waste mass tonnages for the landfill.
 - [10] Accumulative total landfill mass in tons.
 - [11] Accumulative total landfill volume in cubic yards.
 - [12] Remaining capacity.
 - [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
2.00%	1,500	10%	0	0	2%

Medium Rate Increase - 1,500lb/cy Compaction

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy) Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51,541	10,205	61,746	68,721	6,872		75,593	51,541	61,746	75,593	25,189,689	Phase 1	1,038,552							2020-2029
2021	74,462	14,743	89,205	99,283	9,928		109,211	74,462	89,205	184,804	25,080,478		929,341							
2022	92,699	18,354	111,053	123,599	12,360		135,959	92,699	111,053	320,763	24,944,519	595,037	793,382							
2023	77,440	15,333	92,774	103,254	10,325		113,579	170,139	203,827	434,342	24,830,940		679,803							
2024	78,989	15,640	94,629	105,319	10,532	2,106	113,745	249,129	298,456	548,087	24,717,195		566,058							
2025	80,569	15,953	96,522	107,425	10,743	2,149	116,019	329,698	394,978	664,106	24,601,176		450,039							
2026	82,180	16,272	98,452	109,574	10,957	2,191	118,340	411,878	493,430	782,446	24,482,836		331,699							
2027	83,824	16,597	100,421	111,765	11,177	2,235	120,707	495,702	593,851	903,152	24,362,130		210,993							
2028	85,501	16,929	102,430	114,001	11,400	2,280	123,121	581,203	696,281	1,026,273	24,239,009		87,872							
2029	87,211	17,268	104,478	116,281	11,628	2,326	125,583	668,413	800,759	1,151,856	24,113,426	Phase 2	-37,711	2,317,959						2029-2045
2030	88,955	17,613	106,568	118,606	11,861	2,372	128,095	757,368	907,327	1,279,951	23,985,331			2,189,864						
2031	90,734	17,965	108,699	120,978	12,098	2,420	130,657	848,102	1,016,026	1,410,608	23,854,674			2,059,207						
2032	92,549	18,325	110,873	123,398	12,340	2,468	133,270	940,651	1,126,899	1,543,878	23,721,404			1,925,937						
2033	94,400	18,691	113,091	125,866	12,587	2,517	135,935	1,035,050	1,239,990	1,679,813	23,585,469			1,790,002						
2034	96,288	19,065	115,352	128,383	12,838	2,568	138,654	1,131,338	1,355,343	1,818,467	23,446,815			1,651,348						
2035	98,213	19,446	117,659	130,951	13,095	2,619	141,427	1,229,551	1,473,002	1,959,894	23,305,388			1,509,921						
2036	100,178	19,835	120,013	133,570	13,357	2,671	144,256	1,329,728	1,593,015	2,104,150	23,161,132			1,365,665						
2037	102,181	20,232	122,413	136,241	13,624	2,725	147,141	1,431,910	1,715,428	2,251,291	23,013,991			1,218,524						
2038	104,225	20,636	124,861	138,966	13,897	2,779	150,084	1,536,134	1,840,289	2,401,374	22,863,908			1,068,441						
2039	106,309	21,049	127,358	141,746	14,175	2,835	153,085	1,642,443	1,967,647	2,554,460	22,710,822			915,355						
2040	108,435	21,470	129,906	144,580	14,458	2,892	156,147	1,750,879	2,097,553	2,710,606	22,554,676			759,209						
2041	110,604	21,900	132,504	147,472	14,747	2,949	159,270	1,861,483	2,230,056	2,869,876	22,395,406			599,939						
2042	112,816	22,338	135,154	150,422	15,042	3,008	162,455	1,974,299	2,365,210	3,032,332	22,232,950			437,483						
2043	115,072	22,784	137,857	153,430	15,343	3,069	165,704	2,089,371	2,503,067	3,198,036	22,067,246			271,779						
2044	117,374	23,240	140,614	156,499	15,650	3,130	169,018	2,206,745	2,643,681	3,367,054	21,898,228			102,761						
2045	119,721	23,705	143,426	159,629	15,963	3,193	172,399	2,326,467	2,787,107	3,539,453	21,725,829	Phase 3		-69,638	1,890,182					2045-2055
2046	122,116	24,179	146,295	162,821	16,282	3,256	175,847	2,448,583	2,933,402	3,715,300	21,549,982				1,714,335					
2047	124,558	24,663	149,221	166,078	16,608	3,322	179,364	2,573,141	3,082,623	3,894,664	21,370,618				1,534,971					
2048	127,049	25,156	152,205	169,399	16,940	3,388	182,951	2,700,190	3,234,828	4,077,615	21,187,667				1,352,020					
2049	129,590	25,659	155,249	172,787	17,279	3,456	186,610	2,829,780	3,390,077	4,264,225	21,001,057				1,165,410					
2050	132,182	26,172	158,354	176,243	17,624	3,525	190,342	2,961,963	3,548,431	4,454,567	20,810,715				975,068					
2051	134,826	26,695	161,521	179,768	17,977	3,595	194,149	3,096,788	3,709,952	4,648,716	20,616,566				780,919					
2052	137,522	27,229	164,752	183,363	18,336	3,667	198,032	3,234,311	3,874,704	4,846,748	20,418,534				582,887					
2053	140,273	27,774	168,047	187,030	18,703	3,741	201,993	3,374,583	4,042,751	5,048,741	20,216,541				380,894					
2054	143,078	28,329	171,408	190,771	19,077	3,815	206,033	3,517,661	4,214,158	5,254,774	20,010,508				174,861					
2055	145,940	28,896	174,836	194,586	19,459	3,892	210,153	3,663,601	4,388,994	5,464,927	19,800,355	Phase 4			-35,292	3,584,007				2055-2070
2056	148,859	29,474	178,333	198,478	19,848	3,970	214,356	3,812,460	4,567,327	5,679,283	19,585,999				3,369,651					
2057	151,836	30,063	181,899	202,448	20,245	4,049	218,643	3,964,295	4,749,226	5,897,926	19,367,356				3,151,008					
2058	154,872	30,665	185,537	206,497	20,650	4,130	223,016	4,119,168	4,934,763	6,120,943	19,144,339				2,927,991					
2059	157,970	31,278	189,248	210,626	21,063	4,213	227,477	4,277,138	5,124,011	6,348,419	18,916,863				2,700,515					
2060	161,129	31,904	193,033	214,839	21,484	4,297	232,026	4,438,267	5,317,044	6,580,445	18,684,837				2,468,489					
2061	164,352	32,542	196,894	219,136	21,914	4,383	236,667	4,602,619	5,513,937	6,817,112	18,448,170				2,231,822					
2062	167,639	33,192	200,831	223,518	22,352	4,470	241,400	4,770,258	5,714,769	7,058,512	18,206,770				1,990,422					
2063	170,992	33,856	204,848	227,989	22,799	4,560	246,228	4,941,249	5,919,617	7,304,740	17,960,542				1,744,194					
2064	174,411	34,533	208,945	232,549	23,255	4,651	251,153	5,115,661	6,128,562	7,555,893	17,709,389				1,493,041					
2065	177,900	35,224	213,124	237,200	23,720	4,744	256,176	5,293,560	6,341,685	7,812,068	17,453,214				1,236,866					
2066	181,458	35,929	217,386	241,944	24,194	4,839	261,299	5,475,018	6,559,072	8,073,367	17,191,915				975,567					
2067	185,087	36,647	221,734	246,782	24,678	4,936	266,525	5,660,105	6,780,806	8,339,892	16,925,390				709,042					
2068	188,789	37,380	226,169	251,718	25,172	5,034	271,856	5,848,894	7,006,975	8,611,748	16,653,534				437,186					
2069	192,564	38,128	230,692	256,752	25,675	5,135	277,293	6,041,458	7,237,667	8,889,041	16,376,241				159,893					
2070	196,416	38,890	235,306	261,888	26,189	5,238	282,839	6,237,874	7,472,973	9,171,879	16,093,403	Phase 5			-122,945	2,575,880				2070-2079
2071	200,344	39,668	240,012	267,125	26,713	5,343	288,495	6,438,218	7,712,985	9,460,374	15,804,908				2,287,385					
2072	204,351	40,461	244,812	272,468	27,247	5,449	294,265	6,642,568	7,957,797	9,754,640	15,510,642				1,993,119					
2073	208,438	41,271	249,709	277,917	27,792	5,558	300,151	6,851,006	8,207,506	10,054,790	15,210,492				1,692,969					
2074	212,607	42,096	254,703	283,476	28,348	5,670	306,154	7,063,613	8,462,208	10,360,944	14,904,338				1,386,815					
2075	216,859	42,938	259,797	289,145	28,915	5,783	312,277	7,280,472	8,722,005	10,673,220	14,592,062				1,074,539					
2076	221,196	43,797	264,993	294,928	29,493	5,899	318,522	7,501,668	8,986,998	10,991,742	14,273,540				756,017					
2077	225,620	44,673	270,293	300,826	30,083	6,017	324,893	7,727,287	9,257,290	11,316,635	13,948,647				431,124					
2078	230,132	45,566	275,698	306,843	30,684	6,137	331,390	7,957,420	9,532,989	11,648,026	13,617,256				99,733					
2079	234,735	46,478	281,212	312,980	31,298	6,260	338,018	8,192,155	9,814,201	11,986,044	13,									

Projected Site Life
Horn Rapids Landfill Expansion

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)							
	Recorded	Estimated	Total	Calculated	Calculated	Estimated	Total Yearly	Accumulative	Accumulative	Accumulative	Remaining		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest	Total
Year	Disp. Waste	Soil Cover	Mass	Waste Volume	Soil Volume	Organics Diversion	Volume	Waste Mass	Total Mass	Total Volume	Capacity								Expansion	
	(Tons)	(Tons)	(Tons)	(Cubic Yards)	(Cubic Yards)	(Cubic Yards)	(Cubic Yards)	(Tons)	(Tons)	(Cubic Yards)	(Cubic Yards)		1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2085	264,350	52,341	316,691	352,466	35,247	7,049	380,663	9,702,505	11,623,602	14,160,949	11,104,333							561,030		
2086	269,637	53,388	323,025	359,515	35,952	7,190	388,277	9,972,142	11,946,626	14,549,226	10,716,056							172,753		
2087	275,029	54,456	329,485	366,706	36,671	7,334	396,042	10,247,171	12,276,111	14,945,268	10,320,014	Northwest Expansion						-223,289	10,320,014	2087-2108
2088	280,530	55,545	336,075	374,040	37,404	7,481	403,963	10,527,701	12,612,186	15,349,231	9,916,051								9,916,051	
2089	286,141	56,656	342,796	381,521	38,152	7,630	412,042	10,813,842	12,954,983	15,761,273	9,504,009								9,504,009	
2090	291,863	57,789	349,652	389,151	38,915	7,783	420,283	11,105,705	13,304,635	16,181,557	9,083,725								9,083,725	
2091	297,701	58,945	356,645	396,934	39,693	7,939	428,689	11,403,406	13,661,280	16,610,245	8,655,037								8,655,037	
2092	303,655	60,124	363,778	404,873	40,487	8,097	437,263	11,707,060	14,025,058	17,047,508	8,217,774								8,217,774	
2093	309,728	61,326	371,054	412,970	41,297	8,259	446,008	12,016,788	14,396,112	17,493,516	7,771,766								7,771,766	
2094	315,922	62,553	378,475	421,230	42,123	8,425	454,928	12,332,710	14,774,587	17,948,444	7,316,838								7,316,838	
2095	322,241	63,804	386,044	429,654	42,965	8,593	464,027	12,654,951	15,160,631	18,412,471	6,852,811								6,852,811	
2096	328,686	65,080	393,765	438,247	43,825	8,765	473,307	12,983,637	15,554,397	18,885,778	6,379,504								6,379,504	
2097	335,259	66,381	401,641	447,012	44,701	8,940	482,773	13,318,896	15,956,037	19,368,551	5,896,731								5,896,731	
2098	341,964	67,709	409,673	455,953	45,595	9,119	492,429	13,660,860	16,365,711	19,860,980	5,404,302								5,404,302	
2099	348,804	69,063	417,867	465,072	46,507	9,301	502,277	14,009,664	16,783,577	20,363,257	4,902,025								4,902,025	
2100	355,780	70,444	426,224	474,373	47,437	9,487	512,323	14,365,444	17,209,802	20,875,580	4,389,702								4,389,702	
2101	362,895	71,853	434,749	483,861	48,386	9,677	522,569	14,728,339	17,644,550	21,398,149	3,867,133								3,867,133	
2102	370,153	73,290	443,444	493,538	49,354	9,871	533,021	15,098,492	18,087,994	21,931,170	3,334,112								3,334,112	
2103	377,556	74,756	452,313	503,408	50,341	10,068	543,681	15,476,049	18,540,306	22,474,851	2,790,431								2,790,431	
2104	385,107	76,251	461,359	513,477	51,348	10,270	554,555	15,861,156	19,001,665	23,029,406	2,235,876								2,235,876	
2105	392,810	77,776	470,586	523,746	52,375	10,475	565,646	16,253,966	19,472,251	23,595,052	1,670,230								1,670,230	
2106	400,666	79,332	479,998	534,221	53,422	10,684	576,959	16,654,632	19,952,249	24,172,011	1,093,271								1,093,271	
2107	408,679	80,918	489,598	544,906	54,491	10,898	588,498	17,063,311	20,441,846	24,760,509	504,773								504,773	
2108	416,853	82,537	499,390	555,804	55,580	11,116	600,268	17,480,164	20,941,236	25,360,777	0								-95,495	

Notes:

- [1]Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2]Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes a 2% annual increase per the City of Richland, 12-12-2012 thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3]Assume soil mass is approximately 10 percent of annual waste volume.
- [4]Total Landfill Mass: [2] + [3].
- [5]Waste volume assuming a density shown in table (lb/cy).
- [6]Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7]Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8]Total Landfill Volume: [5] + [6].
- [9]Accumulative waste mass tonnages for the landfill.
- [10]Accumulative total landfill mass in tons.
- [11]Accumulative total landfill volume in cubic yards.
- [12]Remaining capacity.
- [13]Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase (Before 2050)	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
5.19%	1,200	10%	0	0	2%

High Rate Increase - 1,200lb/cy Compaction

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)								
	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total	
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282	
2020	51,541	12,756	64,297	85,901	8,590		94,491	51,541	64,297	94,491	25,170,791	Phase 1								1,019,654	
2021	74,462	18,429	92,891	124,103	12,410		136,514	74,462	92,891	231,005	25,034,277									883,140	
2022	92,699	22,943	115,642	154,498	15,450		169,948	92,699	115,642	400,953	24,864,329	427,915								713,192	
2023	82,185	20,341	102,526	136,975	13,698		150,673	174,884	218,168	551,626	24,713,656									562,519	
2024	86,447	21,396	107,843	144,079	14,408	2,882	155,605	261,332	326,011	707,231	24,558,051									406,914	
2025	90,931	22,505	113,436	151,551	15,155	3,031	163,675	352,262	439,447	870,906	24,394,376									243,239	
2026	95,646	23,672	119,319	159,410	15,941	3,188	172,163	447,908	558,766	1,043,070	24,222,212									71,075	
2027	100,606	24,900	125,507	167,677	16,768	3,354	181,092	548,515	684,272	1,224,161	24,041,121	Phase 2	-110,016	2,245,654						2,055,170	
2028	105,824	26,191	132,015	176,373	17,637	3,527	190,483	654,339	816,288	1,414,645	23,850,637									1,854,809	
2029	111,312	27,550	138,862	185,520	18,552	3,710	200,362	765,651	955,150	1,615,006	23,650,276									1,644,056	
2030	117,085	28,978	146,063	195,141	19,514	3,903	210,752	882,736	1,101,213	1,825,759	23,439,523									1,422,374	
2031	123,157	30,481	153,638	205,261	20,526	4,105	221,682	1,005,892	1,254,851	2,047,441	23,217,841									1,189,195	
2032	129,544	32,062	161,606	215,906	21,591	4,318	233,179	1,135,436	1,416,457	2,280,620	22,984,662									943,924	
2033	136,262	33,725	169,987	227,103	22,710	4,542	245,271	1,271,698	1,586,443	2,525,891	22,739,391									685,933	
2034	143,328	35,474	178,802	238,881	23,888	4,778	257,991	1,415,026	1,765,246	2,783,882	22,481,400									414,562	
2035	150,762	37,313	188,075	251,269	25,126	5,025	271,371	1,565,788	1,953,321	3,055,253	22,210,029									129,118	
2036	158,580	39,249	197,829	264,300	26,430	5,286	285,444	1,724,368	2,151,149	3,340,697	21,924,585	Phase 3		-171,129	1,788,691					2037-2043	
2037	166,804	41,284	208,088	278,007	27,801	5,560	300,247	1,891,172	2,359,237	3,640,944	21,624,338									1,472,873	
2038	175,455	43,425	218,880	292,424	29,242	5,848	315,818	2,066,627	2,578,117	3,956,762	21,308,520									1,140,676	
2039	184,554	45,677	230,231	307,589	30,759	6,152	332,197	2,251,180	2,808,347	4,288,959	20,976,323									791,252	
2040	194,125	48,046	242,171	323,541	32,354	6,471	349,424	2,445,305	3,050,518	4,638,383	20,626,899									423,706	
2041	204,192	50,538	254,730	340,320	34,032	6,806	367,546	2,649,497	3,305,248	5,005,929	20,259,353									37,099	
2042	214,781	53,158	267,940	357,969	35,797	7,159	386,607	2,864,278	3,573,187	5,392,536	19,872,746	Phase 4			-369,557	3,249,742				2043-2050	
2043	225,920	55,915	281,835	376,534	37,653	7,531	406,656	3,090,199	3,855,023	5,799,192	19,466,090									2,821,997	
2044	237,636	58,815	296,451	396,061	39,606	7,921	427,746	3,327,835	4,151,474	6,226,937	19,038,345									2,372,068	
2045	249,960	61,865	311,825	416,600	41,660	8,332	449,929	3,577,795	4,463,300	6,676,866	18,588,416									1,898,806	
2046	262,923	65,074	327,997	438,205	43,821	8,764	473,262	3,840,719	4,791,296	7,150,128	18,115,154									1,401,001	
2047	276,559	68,448	345,007	460,931	46,093	9,219	497,805	4,117,277	5,136,303	7,647,933	17,617,349									877,379	
2048	290,901	71,998	362,899	484,835	48,483	9,697	523,622	4,408,178	5,499,202	8,171,555	17,093,727									326,602	
2049	305,987	75,732	381,719	509,979	50,998	10,200	550,777	4,714,165	5,880,921	8,722,332	16,542,950	Phase 5			-252,738	2,446,087				2050-2054	
2050	321,856	79,659	401,515	536,426	53,643	10,729	579,340	5,036,021	6,282,436	9,301,672	15,963,610									1,836,702	
2051	338,547	83,790	422,338	564,245	56,425	11,285	609,385	5,374,568	6,704,774	9,911,057	15,354,225									1,195,714	
2052	356,104	88,136	444,240	593,507	59,351	11,870	640,988	5,730,673	7,149,014	10,552,045	14,713,237									521,484	
2053	374,572	92,707	467,279	624,287	62,429	12,486	674,230	6,105,245	7,616,293	11,226,275	14,039,007	Phase 6				-187,712	2,786,508			2054-2058	
2054	393,998	97,514	491,512	656,663	65,666	13,133	709,196	6,499,242	8,107,805	11,935,471	13,329,811									2,040,534	
2055	414,430	102,572	517,002	690,717	69,072	13,814	745,975	6,913,673	8,624,807	12,681,445	12,583,837									1,255,873	
2056	435,923	107,891	543,814	726,538	72,654	14,531	784,661	7,349,595	9,168,620	13,466,106	11,799,176									430,519	
2057	458,530	113,486	572,016	764,216	76,422	15,284	825,354	7,808,125	9,740,636	14,291,460	10,973,822	Northwest Expansion								-437,638	
2058	482,309	119,372	601,681	803,849	80,385	16,077	868,157	8,290,435	10,342,317	15,159,617	10,105,665									10,105,665	
2059	507,322	125,562	632,884	845,537	84,554	16,911	913,180	8,797,757	10,975,202	16,072,797	9,192,485									9,192,485	
2060	533,632	132,074	665,706	889,387	88,939	17,788	960,537	9,331,389	11,640,907	17,033,334	8,231,948									8,231,948	
2061	561,306	138,923	700,230	935,510	93,551	18,710	1,010,351	9,892,695	12,341,137	18,043,685	7,221,597									7,221,597	
2062	590,416	146,128	736,544	984,026	98,403	19,681	1,062,748	10,483,111	13,077,681	19,106,434	6,158,848									6,158,848	
2063	621,035	153,706	774,741	1,035,058	103,506	20,701	1,117,863	11,104,146	13,852,422	20,224,296	5,040,986									5,040,986	
2064	653,242	161,677	814,919	1,088,736	108,874	21,775	1,175,835	11,757,387	14,667,341	21,400,132	3,865,150									3,865,150	
2065	687,119	170,062	857,181	1,145,199	114,520	22,904	1,236,815	12,444,507	15,524,522	22,636,946	2,628,336									2,628,336	
2066	722,753	178,881	901,635	1,204,589	120,459	24,092	1,300,956	13,167,260	16,426,157	23,937,902	1,327,380									1,327,380	
2067	760,236	188,158	948,394	1,267,059	126,706	25,341	1,368,424	13,927,496	17,374,551	25,306,326	0									-41,044	

Notes:

- Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- Assume soil mass is approximately 10 percent of annual waste volume.
- Total Landfill Mass: [2] + [3].
- Waste volume assuming a density shown in table (lb/cy).
- Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- Total Landfill Volume: [5] + [6].
- Accumulative waste mass tonnages for the landfill.
- Accumulative total landfill mass in tons.
- Accumulative total landfill volume in cubic yards.
- Remaining capacity.
- Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by		Year of Addition	Estimated % Organics Diversion
		Percent of Refuse	Added Waste (Ton)		
5.19%	1,500	10%	0	0	2%

High Rate Increase - 1,500lb/cy Compaction

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
Year	Recorded Disp. (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1							
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51,641	10,205	61,746	68,721	6,872		75,593	51,541	61,746	75,593	25,189,689	Phase 1	1,038,552							2020-2028
2021	74,462	14,743	89,205	99,283	9,928		109,211	74,462	89,205	104,804	25,080,478									
2022	92,699	18,354	111,053	123,599	12,360		135,959	92,699	111,053	130,763	24,944,519	595,037	793,382							
2023	82,185	16,273	98,458	109,580	10,958		120,538	174,884	209,511	241,301	24,823,981									
2024	86,447	17,117	103,564	115,263	11,526	2,305	124,484	261,332	313,075	269,499	24,699,497									
2025	90,931	18,004	108,935	121,241	12,124	2,425	130,940	352,262	422,010	269,725	24,568,557									
2026	95,646	18,938	114,584	127,528	12,753	2,551	137,731	447,908	536,594	279,689	24,430,826									
2027	100,606	19,920	120,527	134,142	13,414	2,683	144,873	548,515	657,121	297,329	24,285,953									
2028	105,824	20,953	126,777	141,099	14,110	2,822	152,387	654,339	783,898	317,176	24,133,566	Phase 2	-17,571	2,338,099						
2029	111,312	22,040	133,352	148,416	14,842	2,968	160,289	765,651	917,250	339,727	23,973,277			2,177,810						
2030	117,085	23,183	140,267	156,113	15,611	3,122	168,602	882,736	1,057,517	360,607	23,804,675			2,009,208						
2031	123,157	24,385	147,542	164,209	16,421	3,284	177,346	1,005,892	1,205,059	387,953	23,627,329			1,831,862						
2032	129,544	25,650	155,193	172,725	17,272	3,454	186,543	1,135,436	1,360,253	415,496	23,440,786			1,645,319						
2033	136,262	26,980	163,242	181,682	18,168	3,634	196,217	1,271,698	1,523,494	445,569	23,244,569			1,449,102						
2034	143,328	28,379	171,707	191,105	19,110	3,822	206,393	1,415,026	1,695,202	476,106	23,038,176			1,242,709						
2035	150,762	29,851	180,612	201,015	20,102	4,020	217,097	1,565,788	1,875,814	506,202	22,821,080			1,025,613						
2036	158,580	31,399	189,979	211,440	21,144	4,229	228,355	1,724,368	2,065,793	536,558	22,592,724			797,257						
2037	166,804	33,027	199,831	222,405	22,241	4,448	240,198	1,891,172	2,265,624	567,060	22,352,527			557,060						
2038	175,455	34,740	210,195	233,939	23,394	4,679	252,655	2,066,627	2,475,819	597,405	22,099,872			304,405						
2039	184,554	36,542	221,095	246,072	24,607	4,921	265,757	2,251,180	2,696,914	627,115	21,834,115			38,648						
2040	194,125	38,437	232,561	258,833	25,883	5,177	279,540	2,445,305	2,929,475	657,707	21,554,575	Phase 3	-240,892	1,718,928						
2041	204,192	40,430	244,622	272,256	27,226	5,445	294,037	2,649,497	3,174,097	688,430	21,260,539			1,424,892						
2042	214,781	42,527	257,308	286,375	28,638	5,728	309,285	2,864,278	3,431,406	718,029	20,951,253			1,115,606						
2043	225,920	44,732	270,652	301,227	30,123	6,025	325,325	3,090,199	3,702,058	748,354	20,625,928			790,281						
2044	237,636	47,052	284,688	316,849	31,685	6,337	342,196	3,327,835	3,986,746	788,500	20,283,732			448,085						
2045	249,960	49,492	299,452	333,280	33,328	6,666	359,943	3,577,795	4,286,199	828,199	19,923,789			88,142						
2046	262,923	52,059	314,982	350,564	35,056	7,011	378,610	3,840,719	4,601,181	868,102	19,545,180	Phase 4		-290,467	3,328,832					
2047	276,559	54,759	331,317	368,745	36,874	7,375	398,244	4,117,277	4,932,498	908,347	19,146,935			2,930,587						
2048	290,901	57,598	348,499	387,868	38,787	7,757	418,897	4,408,178	5,280,997	948,244	18,728,038			2,511,690						
2049	305,987	60,585	366,573	407,983	40,798	8,160	440,622	4,714,165	5,647,570	988,416	18,287,416			2,071,068						
2050	321,856	63,727	385,583	429,141	42,914	8,583	463,472	5,036,021	6,033,153	1,028,344	17,823,944			1,607,596						
2051	338,547	67,032	405,580	451,396	45,140	9,028	487,508	5,374,568	6,438,733	1,068,436	17,336,436			1,120,088						
2052	356,104	70,509	426,613	474,806	47,481	9,496	512,790	5,730,673	6,865,346	1,108,636	16,823,646			607,298						
2053	374,572	74,165	448,737	499,429	49,943	9,989	539,384	6,105,245	7,314,083	1,148,020	16,284,262			67,914						
2054	393,998	78,012	472,009	525,330	52,533	10,507	567,356	6,499,242	7,786,092	1,188,377	15,716,905	Phase 5		-499,443	2,199,382					
2055	414,430	82,057	496,488	552,574	55,257	11,051	596,780	6,913,673	8,282,580	1,228,156	15,120,126			1,602,603						
2056	435,923	86,313	522,236	581,230	58,123	11,625	627,729	7,349,595	8,804,815	1,268,885	14,492,397			974,874						
2057	458,530	90,789	549,319	611,373	61,137	12,227	660,283	7,808,125	9,354,134	1,313,168	13,832,114			314,591						
2058	482,309	95,497	577,807	643,079	64,308	12,862	694,525	8,290,435	9,931,941	1,363,694	13,137,588	Phase 6		-379,935	2,594,285					
2059	507,322	100,450	607,772	676,429	67,643	13,529	730,544	8,797,757	10,539,713	1,418,237	12,407,045			1,863,742						
2060	533,632	105,859	639,291	711,509	71,151	14,230	768,430	9,331,389	11,179,004	1,473,667	11,638,615			1,095,312						
2061	561,306	111,139	672,445	748,408	74,841	14,968	808,281	9,892,695	11,851,449	1,528,948	10,830,334			287,031						
2062	590,416	116,902	707,318	787,221	78,722	15,744	850,199	10,483,111	12,558,767	1,583,147	9,980,135	Northwest Expansion			-563,168	9,980,135				
2063	621,035	122,965	744,000	828,046	82,805	16,561	894,290	11,104,146	13,302,766	1,639,437	9,085,845									
2064	653,242	129,342	782,584	870,989	87,099	17,420	940,668	11,757,387	14,085,350	1,700,105	8,145,177									
2065	687,119	136,050	823,169	916,159	91,616	18,323	989,452	12,444,507	14,908,519	1,759,557	7,155,725									
2066	722,753	143,105	865,859	963,671	96,367	19,273	1,040,765	13,167,260	15,774,377	1,810,322	6,114,960									
2067	760,236	150,527	910,762	1,013,647	101,365	20,273	1,094,739	13,927,496	16,685,140	2,045,061	5,020,221									
2068	799,662	158,333	957,995	1,066,215	106,622	21,324	1,151,513	14,727,157	17,643,134	2,196,574	3,868,708									
2069	841,132	166,544	1,007,676	1,121,510	112,151	22,430	1,211,230	15,568,289	18,650,811	2,260,804	2,657,478									
2070	884,754	175,181	1,059,935	1,179,671	117,967	23,593	1,274,045	16,453,043	19,710,745	2,381,849	1,383,433									
2071	930,637	184,266	1,114,903	1,240,850	124,085	24,817	1,340,118	17,383,680	20,825,649	25,221,967	43,315									
2072	978,900	193,822	1,172,723	1,305,200	130,520	26,104	1,409,616	18,362,580	21,998,371	26,631,583	0									

Notes:

- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3] Assume soil mass is approximately 10 percent of annual waste volume.
- [4] Total Landfill Mass: [2] + [3].
- [5] Waste volume assuming a density shown in table (lb/cy).
- [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8] Total Landfill Volume: [5] + [6].
- [9] Accumulative waste mass tonnages for the landfill.
- [10] Accumulative total landfill mass in tons.
- [11] Accumulative total landfill volume in cubic yards.
- [12] Remaining capacity.
- [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

**Projected Site Life
Horn Rapids Landfill Expansion**

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
2.00%	1,200	10%	80,000	2026	2%

Medium Rate Increase - 1,200lb/cy Compaction with Expanded Service Area

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)							
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51541	12,756	64,297	85,901	8,590		94,491	51,541	64,297	94,491	25,170,791	Phase 1	1,019,654							2020-2026
2021	74462	18,429	92,891	124,103	12,410		136,514	74,462	92,891	231,005	25,034,277		883,140							
2022	92699	22,943	115,642	154,498	15,450		169,948	92,699	115,642	400,953	24,864,329		713,192							
2023	77,440	19,167	96,607	129,067	12,907		141,974	170,139	212,249	542,927	24,722,355	427,915								
2024	78,989	19,550	98,539	131,649	13,165	2,633	142,181	249,129	310,788	685,108	24,580,174		429,037							
2025	80,569	19,941	100,510	134,282	13,428	2,686	145,024	329,698	411,298	830,132	24,435,150		284,013							
2026	162,180	40,140	202,320	270,301	27,030	5,406	291,925	491,878	613,618	1,122,057	24,143,225	Phase 2	-7,912	2,347,758						2026-2034
2027	165,424	40,942	206,367	275,707	27,571	5,514	297,763	657,302	819,985	1,419,821	23,845,461			2,049,994						
2028	168,733	41,761	210,494	281,221	28,122	5,624	303,719	826,035	1,030,479	1,723,539	23,541,743			1,746,276						
2029	172,107	42,597	214,704	286,845	28,685	5,737	309,793	998,142	1,245,182	2,033,332	23,231,950			1,436,483						
2030	175,549	43,448	218,998	292,582	29,258	5,852	315,989	1,173,691	1,464,180	2,349,321	22,915,961			1,120,494						
2031	179,060	44,317	223,378	298,434	29,843	5,969	322,309	1,352,752	1,687,558	2,671,630	22,593,652			798,185						
2032	182,642	45,204	227,845	304,403	30,440	6,088	328,755	1,535,393	1,915,403	3,000,384	22,264,898			469,431						
2033	186,294	46,108	232,402	310,491	31,049	6,210	335,330	1,721,688	2,147,805	3,335,714	21,929,568			134,101						
2034	190,020	47,030	237,050	316,700	31,670	6,334	342,036	1,911,708	2,384,856	3,677,751	21,587,531	Phase 3		-207,936	1,751,884					2034-2039
2035	193,821	47,971	241,791	323,034	32,303	6,461	348,877	2,105,529	2,626,647	4,026,628	21,238,654				1,403,007					
2036	197,697	48,930	246,627	329,495	32,950	6,590	355,855	2,303,226	2,873,274	4,382,483	20,882,799				1,047,152					
2037	201,651	49,909	251,560	336,085	33,609	6,722	362,972	2,504,877	3,124,834	4,745,454	20,519,828				684,181					
2038	205,684	50,907	256,591	342,807	34,281	6,856	370,231	2,710,561	3,381,424	5,115,686	20,149,596				313,949					
2039	209,798	51,925	261,723	349,663	34,966	6,993	377,636	2,920,358	3,643,147	5,493,322	19,771,960	Phase 4		-63,687		3,555,612				2039-2048
2040	213,994	52,963	266,957	356,656	35,666	7,133	385,189	3,134,352	3,910,104	5,878,510	19,386,772					3,170,424				
2041	218,274	54,023	272,296	363,789	36,379	7,276	392,892	3,352,626	4,182,400	6,271,403	18,993,879					2,777,531				
2042	222,639	55,103	277,742	371,065	37,107	7,421	400,750	3,575,265	4,460,143	6,672,153	18,593,129					2,376,781				
2043	227,092	56,205	283,297	378,486	37,849	7,570	408,765	3,802,356	4,743,440	7,080,918	18,184,364					1,968,016				
2044	231,634	57,329	288,963	386,056	38,606	7,721	416,941	4,033,990	5,032,403	7,497,858	17,767,424					1,551,076				
2045	236,266	58,476	294,742	393,777	39,378	7,876	425,279	4,270,256	5,327,145	7,923,138	17,342,144					1,125,796				
2046	240,992	59,645	300,637	401,653	40,165	8,033	433,785	4,511,248	5,627,782	8,356,923	16,908,359					692,011				
2047	245,811	60,838	306,650	409,686	40,969	8,194	442,461	4,757,059	5,934,432	8,799,383	16,465,899					249,551				
2048	250,728	62,055	312,783	417,879	41,788	8,358	451,310	5,007,787	6,247,214	9,250,693	16,014,589	Phase 5			-201,759		2,497,066			2048-2054
2049	255,742	63,296	319,038	426,237	42,624	8,525	460,336	5,263,529	6,566,253	9,711,029	15,554,253					2,036,730				
2050	260,857	64,562	325,419	434,762	43,476	8,695	469,543	5,524,386	6,891,672	10,180,572	15,084,710					1,567,187				
2051	266,074	65,853	331,928	443,457	44,346	8,869	478,934	5,790,461	7,223,600	10,659,506	14,605,776					1,088,253				
2052	271,396	67,170	338,566	452,326	45,233	9,047	488,512	6,061,856	7,562,166	11,148,018	14,117,264					599,741				
2053	276,824	68,514	345,337	461,373	46,137	9,227	498,283	6,338,680	7,907,503	11,646,300	13,618,982					101,459				
2054	282,360	69,884	352,244	470,600	47,060	9,412	508,248	6,621,040	8,259,748	12,154,549	13,110,733	Phase 6				-406,790	2,567,430			2054-2059
2055	288,007	71,282	359,289	480,012	48,001	9,600	518,413	6,909,047	8,619,037	12,672,962	12,592,320					2,049,017				
2056	293,767	72,707	366,475	489,612	48,961	9,792	528,781	7,202,815	8,985,512	13,201,743	12,063,539					1,520,236				
2057	299,643	74,162	373,804	499,405	49,940	9,988	538,357	7,502,458	9,359,316	13,741,100	11,524,182					980,879				
2058	305,636	75,645	381,280	509,393	50,939	10,188	550,144	7,808,093	9,740,596	14,291,244	10,974,038					430,735				
2059	311,748	77,158	388,906	519,581	51,958	10,392	561,147	8,119,842	10,129,503	14,852,391	10,412,891	Northwest Expansion					-130,412	10,412,891	2059-2075	
2060	317,983	78,701	396,684	529,972	52,997	10,599	572,370	8,437,825	10,526,187	15,424,761	9,840,521					9,840,521				
2061	324,343	80,275	404,618	540,572	54,057	10,811	583,817	8,762,168	10,930,805	16,008,579	9,256,703					9,256,703				
2062	330,830	81,880	412,710	551,383	55,138	11,028	595,494	9,092,998	11,343,515	16,604,073	8,661,209					8,661,209				
2063	337,446	83,518	420,964	562,411	56,241	11,248	607,404	9,430,444	11,764,479	17,211,476	8,053,806					8,053,806				
2064	344,195	85,188	429,384	573,659	57,366	11,473	619,552	9,774,640	12,193,863	17,831,028	7,434,254					7,434,254				
2065	351,079	86,892	437,971	585,132	58,513	11,703	631,943	10,125,719	12,631,835	18,462,971	6,802,311					6,802,311				
2066	358,101	88,630	446,731	596,835	59,683	11,937	644,582	10,483,820	13,078,565	19,107,552	6,157,730					6,157,730				
2067	365,263	90,403	455,665	608,771	60,877	12,175	657,473	10,849,083	13,534,231	19,765,025	5,500,257					5,500,257				
2068	372,568	92,211	464,779	620,947	62,095	12,419	670,623	11,221,651	13,999,010	20,435,648	4,829,634					4,829,634				
2069	380,020	94,055	474,074	633,366	63,337	12,667	684,035	11,601,671	14,473,084	21,119,683	4,145,599					4,145,599				
2070	387,620	95,936	483,556	646,033	64,603	12,921	697,716	11,989,290	14,956,640	21,817,399	3,447,883					3,447,883				
2071	395,372	97,855	493,227	658,954	65,895	13,179	711,670	12,384,663	15,449,867	22,529,069	2,736,213					2,736,213				
2072	403,280	99,812	503,091	672,133	67,213	13,443	725,904	12,787,943	15,952,958	23,254,973	2,010,309					2,010,309				
2073	411,345	101,808	513,153	685,576	68,558	13,712	740,422	13,199,288	16,466,112	23,995,395	1,269,887					1,269,887				
2074	419,572	103,844	523,416	699,287	69,929	13,986	755,230	13,618,860	16,989,528	24,750,625	514,657					514,657				
2075	427,964	105,921	533,885	713,273	71,327	14,265	770,335	14,046,824	17,523,413	25,520,959	0									-255,677

Notes:

- Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes a 2% annual increase per the City of Richland, 12-12-2012 thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- Assume soil mass is approximately 10 percent of annual waste volume.
- Total Landfill Mass: [2] + [3].
- Waste volume assuming a density shown in table (lb/cy).
- Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 202

Projected Site Life
Horn Rapids Landfill Expansion

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated percent organics diversion
2.00%	1,500	10%	80,000	2026	2%

Medium Rate Increase - 1,500lb/cy Compaction with Expanded Service Area

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)	Phase 1	1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282
2020	51,541	10,205	61,746	68,721	6,872		75,593	51,541	61,746	75,593	25,189,689	Phase 1	1,038,552							2020-2027
2021	74,462	14,743	89,205	99,283	9,928		109,211	74,462	89,205	184,804	25,080,478		929,341							
2022	92,699	18,354	111,053	123,599	12,360		135,959	92,699	111,053	320,763	24,944,519	595,037	793,382							
2023	77,440	15,333	92,774	103,254	10,325		113,579	170,139	203,827	434,342	24,830,940		679,803							
2024	78,989	15,640	94,629	105,319	10,532	2,106	113,745	249,129	298,456	548,087	24,717,195		566,058							
2025	80,569	15,953	96,522	107,425	10,743	2,149	116,019	329,698	394,978	664,106	24,601,176		450,039							
2026	162,180	32,112	194,292	216,241	21,624	4,325	233,540	491,878	589,270	897,646	24,367,636		216,499							
2027	165,424	32,754	198,178	220,565	22,057	4,411	238,211	657,302	787,448	1,135,856	24,129,426	Phase 2	-21,711	2,333,959					2027-2036	
2028	168,733	33,409	202,142	224,977	22,498	4,500	242,975	826,035	989,590	1,378,831	23,886,451		2,090,984							
2029	172,107	34,077	206,184	229,476	22,948	4,590	247,834	998,142	1,195,774	1,626,666	23,638,616		1,843,149							
2030	175,549	34,759	210,308	234,066	23,407	4,681	252,791	1,173,691	1,406,082	1,879,457	23,385,825		1,590,358							
2031	179,060	35,454	214,514	238,747	23,875	4,775	257,847	1,352,752	1,620,597	2,137,304	23,127,978		1,332,511							
2032	182,642	36,163	218,805	243,522	24,352	4,870	263,004	1,535,393	1,839,401	2,400,307	22,864,975		1,069,508							
2033	186,294	36,886	223,181	248,392	24,839	4,968	268,264	1,721,688	2,062,582	2,668,571	22,596,711		801,244							
2034	190,020	37,624	227,644	253,360	25,336	5,067	273,629	1,911,708	2,290,226	2,942,201	22,323,081		527,614							
2035	193,821	38,376	232,197	258,428	25,843	5,169	279,102	2,105,529	2,522,423	3,221,302	22,043,980		248,513							
2036	197,697	39,144	236,841	263,596	26,360	5,272	284,684	2,303,226	2,759,264	3,505,986	21,759,296	Phase 3	-36,171	1,923,649					2036-2043	
2037	201,651	39,927	241,578	268,868	26,887	5,377	290,377	2,504,877	3,000,842	3,796,364	21,468,918		1,627,464							
2038	205,684	40,725	246,409	274,245	27,425	5,485	296,185	2,710,561	3,247,252	4,092,549	21,172,733		1,325,355							
2039	209,798	41,540	251,338	279,730	27,973	5,595	302,109	2,920,358	3,498,589	4,394,657	20,870,625		1,017,204							
2040	213,994	42,371	256,364	285,325	28,532	5,706	308,151	3,134,352	3,754,954	4,702,808	20,562,474		702,890							
2041	218,274	43,218	261,492	291,031	29,103	5,821	314,314	3,352,626	4,016,446	5,017,122	20,248,160		382,290							
2042	222,639	44,083	266,722	296,852	29,685	5,937	320,600	3,575,265	4,283,167	5,337,722	19,927,560		55,278							
2043	227,092	44,964	272,056	302,789	30,279	6,056	327,012	3,802,356	4,555,223	5,664,734	19,600,548	Phase 4	-278,274	3,341,025					2043-2053	
2044	231,634	45,863	277,497	308,845	30,884	6,177	333,552	4,033,990	4,832,720	5,998,287	19,266,995		3,007,472							
2045	236,266	46,781	283,047	315,022	31,502	6,300	340,223	4,270,256	5,115,767	6,338,510	18,926,772		2,667,249							
2046	240,992	47,716	288,708	321,322	32,132	6,426	347,028	4,511,248	5,404,475	6,685,538	18,579,744		2,320,221							
2047	245,811	48,671	294,482	327,749	32,775	6,555	353,969	4,757,059	5,698,957	7,039,507	18,225,775		1,966,252							
2048	250,728	49,644	300,372	334,304	33,430	6,686	361,048	5,007,787	5,999,329	7,400,555	17,864,727		1,605,204							
2049	255,742	50,637	306,379	340,990	34,099	6,820	368,269	5,263,529	6,305,708	7,768,823	17,496,459		1,236,936							
2050	260,857	51,650	312,507	347,809	34,781	6,956	375,634	5,524,386	6,618,215	8,144,458	17,120,824		861,301							
2051	266,074	52,683	318,757	354,766	35,477	7,095	383,147	5,790,461	6,936,972	8,527,605	16,737,677		478,155							
2052	271,396	53,736	325,132	361,861	36,186	7,237	390,810	6,061,856	7,262,104	8,918,414	16,346,868		87,345							
2053	276,824	54,811	331,635	369,098	36,910	7,382	398,626	6,338,680	7,593,739	9,317,040	15,948,242	Phase 5	-311,281	2,387,544					2053-2059	
2054	282,360	55,907	338,267	376,480	37,648	7,530	406,599	6,621,040	7,932,006	9,723,639	15,541,643		1,980,945							
2055	288,007	57,025	345,033	384,010	38,401	7,680	414,731	6,909,047	8,277,039	10,138,369	15,126,913		1,566,215							
2056	293,767	58,166	351,933	391,690	39,169	7,834	423,025	7,202,815	8,628,972	10,561,395	14,703,887		1,143,189							
2057	299,643	59,329	358,972	399,524	39,952	7,990	431,486	7,502,458	8,987,944	10,992,880	14,272,402		711,704							
2058	305,636	60,516	366,152	407,514	40,751	8,150	440,115	7,808,093	9,354,096	11,432,996	13,832,286		271,588							
2059	311,748	61,726	373,475	415,664	41,566	8,313	448,918	8,119,842	9,727,570	11,881,913	13,383,369	Phase 6	-177,329	2,796,891					2059-2065	
2060	317,983	62,961	380,944	423,978	42,398	8,480	457,896	8,437,825	10,108,514	12,339,809	12,925,473		2,338,995							
2061	324,343	64,220	388,563	432,457	43,246	8,649	467,054	8,762,168	10,497,077	12,806,863	12,458,419		1,871,941							
2062	330,830	65,504	396,334	441,106	44,111	8,822	476,395	9,092,998	10,893,412	13,283,258	11,982,024		1,395,546							
2063	337,446	66,814	404,261	449,929	44,993	8,999	485,923	9,430,444	11,297,672	13,769,181	11,496,101		909,623							
2064	344,195	68,151	412,346	458,927	45,893	9,179	495,641	9,774,640	11,710,018	14,264,822	11,000,460		413,982							
2065	351,079	69,514	420,593	468,106	46,811	9,362	505,554	10,125,719	12,130,611	14,770,377	10,494,905	Northwest Expansion	-91,573	10,451,730					2065-2083	
2066	358,101	70,904	429,005	477,468	47,747	9,549	515,665	10,483,820	12,559,616	15,286,042	9,979,240		9,936,065							
2067	365,263	72,322	437,585	487,017	48,702	9,740	525,979	10,849,083	12,997,201	15,812,020	9,453,262		9,410,087							
2068	372,568	73,768	446,337	496,758	49,676	9,935	536,498	11,221,651	13,443,538	16,348,519	8,916,763		8,873,588							
2069	380,020	75,244	455,263	506,693	50,669	10,134	547,228	11,601,671	13,898,801	16,895,747	8,369,535		8,326,360							
2070	387,620	76,749	464,369	516,827	51,683	10,337	558,173	11,989,290	14,											

Projected Site Life
Horn Rapids Landfill Expansion

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	Capacity (cy)							
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Northwest Expansion	Total
													1,114,145	2,355,670	1,959,820	3,619,299	2,698,825	2,974,220	10,543,303	25,265,282

- Notes:
- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
 - [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes a 2% annual increase per the City of Richland, 12-12-2012 thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
 - [3] Assume soil mass is approximately 10 percent of annual waste volume.
 - [4] Total Landfill Mass: [2] + [3].
 - [5] Waste volume assuming a density shown in table (lb/cy).
 - [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
 - [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
 - [8] Total Landfill Volume: [5] + [6].
 - [9] Accumulative waste mass tonnages for the landfill.
 - [10] Accumulative total landfill mass in tons.
 - [11] Accumulative total landfill volume in cubic yards.
 - [12] Remaining capacity.
 - [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

**Projected Site Life
Horn Rapids Landfill Expansion**

Waste Yearly Increase	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
1.12%	1,500	10%	0	0	10%

**Low Rate Increase - 1,500lb/cy Compaction with 10%
Organics Removal**

Added Site Life by 10% Diversion of Organics (Years): 5

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)
2020	51,541	10,205	61,746	68,721	6,872		75,593	51,541	61,746	75,593	25,189,689
2021	74,462	14,743	89,205	99,283	9,928		109,211	74,462	89,205	184,804	25,080,478
2022	92,699	18,354	111,053	123,599	12,360		135,959	92,699	111,053	320,763	24,944,519
2023	76,129	15,074	91,203	101,505	10,151		111,656	168,828	202,256	432,419	24,832,863
2024	76,981	15,242	92,224	102,642	10,264	10,264	102,642	245,809	294,480	535,060	24,730,222
2025	77,843	15,413	93,256	103,791	10,379	10,379	103,791	323,653	387,736	638,851	24,626,431
2026	78,715	15,585	94,300	104,953	10,495	10,495	104,953	402,367	482,036	743,804	24,521,478
2027	79,596	15,760	95,356	106,128	10,613	10,613	106,128	481,963	577,391	849,931	24,415,351
2028	80,487	15,936	96,423	107,316	10,732	10,732	107,316	562,449	673,814	957,247	24,308,035
2029	81,388	16,115	97,502	108,517	10,852	10,852	108,517	643,837	771,317	1,065,764	24,199,518
2030	82,299	16,295	98,594	109,732	10,973	10,973	109,732	726,136	869,911	1,175,496	24,089,786
2031	83,220	16,478	99,698	110,960	11,096	11,096	110,960	809,356	969,608	1,286,456	23,978,826
2032	84,152	16,662	100,814	112,202	11,220	11,220	112,202	893,508	1,070,422	1,398,658	23,866,624
2033	85,094	16,849	101,942	113,458	11,346	11,346	113,458	978,601	1,172,364	1,512,116	23,753,166
2034	86,046	17,037	103,083	114,728	11,473	11,473	114,728	1,064,648	1,275,448	1,626,845	23,638,437
2035	87,010	17,228	104,237	116,013	11,601	11,601	116,013	1,151,657	1,379,685	1,742,857	23,522,425
2036	87,984	17,421	105,404	117,311	11,731	11,731	117,311	1,239,641	1,485,089	1,860,169	23,405,113
2037	88,968	17,616	106,584	118,625	11,862	11,862	118,625	1,328,609	1,591,674	1,978,793	23,286,489
2038	89,964	17,813	107,777	119,953	11,995	11,995	119,953	1,418,573	1,699,451	2,098,746	23,166,536
2039	90,971	18,012	108,984	121,295	12,130	12,130	121,295	1,509,545	1,808,435	2,220,041	23,045,241
2040	91,990	18,214	110,204	122,653	12,265	12,265	122,653	1,601,535	1,918,639	2,342,694	22,922,588
2041	93,020	18,418	111,438	124,026	12,403	12,403	124,026	1,694,554	2,030,076	2,466,720	22,798,562
2042	94,061	18,624	112,685	125,415	12,541	12,541	125,415	1,788,615	2,142,761	2,592,135	22,673,137
2043	95,114	18,833	113,946	126,819	12,682	12,682	126,819	1,883,729	2,256,708	2,718,954	22,546,328
2044	96,179	19,043	115,222	128,238	12,824	12,824	128,238	1,979,908	2,371,930	2,847,192	22,418,090
2045	97,255	19,257	116,512	129,674	12,967	12,967	129,674	2,077,163	2,488,442	2,976,865	22,288,417
2046	98,344	19,472	117,816	131,125	13,113	13,113	131,125	2,175,507	2,606,258	3,107,991	22,157,291
2047	99,445	19,690	119,135	132,593	13,259	13,259	132,593	2,274,952	2,725,393	3,240,584	22,024,698
2048	100,558	19,911	120,469	134,078	13,408	13,408	134,078	2,375,510	2,845,861	3,374,662	21,890,620
2049	101,684	20,133	121,817	135,578	13,558	13,558	135,578	2,477,194	2,967,679	3,510,240	21,755,042
2050	102,822	20,359	123,181	137,096	13,710	13,710	137,096	2,580,016	3,090,860	3,647,336	21,617,946
2051	103,973	20,587	124,560	138,631	13,863	13,863	138,631	2,683,990	3,215,419	3,785,967	21,479,315
2052	105,137	20,817	125,954	140,183	14,018	14,018	140,183	2,789,127	3,341,374	3,926,150	21,339,132
2053	106,314	21,050	127,364	141,752	14,175	14,175	141,752	2,895,441	3,468,738	4,067,902	21,197,380
2054	107,504	21,286	128,790	143,339	14,334	14,334	143,339	3,002,945	3,597,528	4,211,241	21,054,041
2055	108,708	21,524	130,232	144,943	14,494	14,494	144,943	3,111,652	3,727,760	4,356,184	20,909,098
2056	109,925	21,765	131,690	146,566	14,657	14,657	146,566	3,221,577	3,859,449	4,502,750	20,762,532
2057	111,155	22,009	133,164	148,207	14,821	14,821	148,207	3,332,732	3,992,613	4,650,957	20,614,325
2058	112,399	22,255	134,654	149,866	14,987	14,987	149,866	3,445,131	4,127,267	4,800,823	20,464,459
2059	113,658	22,504	136,162	151,543	15,154	15,154	151,543	3,558,789	4,263,429	4,952,366	20,312,916
2060	114,930	22,756	137,686	153,240	15,324	15,324	153,240	3,673,719	4,401,115	5,105,606	20,159,676
2061	116,217	23,011	139,227	154,955	15,496	15,496	154,955	3,789,935	4,540,343	5,260,562	20,004,720
2062	117,517	23,268	140,786	156,690	15,669	15,669	156,690	3,907,453	4,681,129	5,417,252	19,848,030
2063	118,833	23,529	142,362	158,444	15,844	15,844	158,444	4,026,286	4,823,491	5,575,696	19,689,586
2064	120,163	23,792	143,956	160,218	16,022	16,022	160,218	4,146,449	4,967,446	5,735,913	19,529,369
2065	121,508	24,059	145,567	162,011	16,201	16,201	162,011	4,267,958	5,113,013	5,897,925	19,367,357
2066	122,869	24,328	147,197	163,825	16,382	16,382	163,825	4,390,826	5,260,210	6,061,750	19,203,532
2067	124,244	24,600	148,844	165,659	16,566	16,566	165,659	4,515,070	5,409,054	6,227,408	19,037,874
2068	125,635	24,876	150,511	167,513	16,751	16,751	167,513	4,640,705	5,559,565	6,394,922	18,870,360
2069	127,041	25,154	152,196	169,388	16,939	16,939	169,388	4,767,747	5,711,761	6,564,310	18,700,972
2070	128,464	25,436	153,899	171,285	17,128	17,128	171,285	4,896,210	5,865,660	6,735,595	18,529,687
2071	129,902	25,721	155,622	173,202	17,320	17,320	173,202	5,026,112	6,021,282	6,908,797	18,356,485
2072	131,356	26,008	157,364	175,141	17,514	17,514	175,141	5,157,468	6,178,646	7,083,938	18,181,344
2073	132,826	26,300	159,126	177,102	17,710	17,710	177,102	5,290,294	6,337,772	7,261,040	18,004,242
2074	134,313	26,594	160,907	179,084	17,908	17,908	179,084	5,424,607	6,498,679	7,440,124	17,825,158
2075	135,817	26,892	162,708	181,089	18,109	18,109	181,089	5,560,424	6,661,388	7,621,213	17,644,069
2076	137,337	27,193	164,530	183,116	18,312	18,312	183,116	5,697,761	6,825,917	7,804,329	17,460,953
2077	138,874	27,497	166,372	185,166	18,517	18,517	185,166	5,836,635	6,992,289	7,989,495	17,275,787
2078	140,429	27,805	168,234	187,239	18,724	18,724	187,239	5,977,064	7,160,523	8,176,733	17,088,549
2079	142,001	28,116	170,117	189,335	18,933	18,933	189,335	6,119,065	7,330,640	8,366,068	16,899,214
2080	143,591	28,431	172,022	191,454	19,145	19,145	191,454	6,262,656	7,502,662	8,557,523	16,707,759
2081	145,198	28,749	173,947	193,598	19,360	19,360	193,598	6,407,854	7,676,609	8,751,120	16,514,162
2082	146,824	29,071	175,895	195,765	19,576	19,576	195,765	6,554,678	7,852,504	8,946,885	16,318,397
2083	148,467	29,396	177,864	197,956	19,796	19,796	197,956	6,703,145	8,030,368	9,144,841	16,120,441
2084	150,129	29,726	179,855	200,172	20,017	20,017	200,172	6,853,274	8,210,222	9,345,013	15,920,269
2085	151,810	30,058	181,868	202,413	20,241	20,241	202,413	7,005,084	8,392,090	9,547,426	15,717,856
2086	153,509	30,395	183,904	204,679	20,468	20,468	204,679	7,158,593	8,575,994	9,752,105	15,513,177
2087	155,228	30,735	185,963	206,970	20,697	20,697	206,970	7,313,821	8,761,957	9,959,075	15,306,207
2088	156,965	31,079	188,044	209,287	20,929	20,929	209,287	7,470,786	8,950,002	10,168,362	15,096,920
2089	158,722	31,427	190,149	211,630	21,163	21,163	211,630	7,629,508	9,140,151	10,379,992	14,885,290
2090	160,499	31,779	192,278	213,999	21,400	21,400	213,999	7,790,008	9,332,429	10,593,991	14,671,291
2091	162,296	32,135	194,431	216,395	21,639	21,639	216,395	7,952,304	9,526,860	10,810,386	14,454,896
2092	164,113	32,494	196,607	218,817	21,882	21,882	218,817	8,116,416	9,723,467	11,029,203	14,236,079
2093	165,950	32,858	198,808	221,267	22,127	22,127	221,267	8,282,366	9,922,275	11,250,469	14,014,813
2094	167,808	33,226	201,034	223,743	22,374	22,374	223,743	8,450,174	10,123,308	11,474,213	13,791,069
2095	169,686	33,598	203,284	226,248	22,625	22,625	226,248	8,619,860	10,326,592	11,700,461	13,564,821
2096	171,586	33,974	205,560	228,781	22,878	22,878	228,781	8,791,446	10,532,152	11,929,242	13,336,040

**Projected Site Life
Horn Rapids Landfill Expansion**

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)
2097	173,506	34,354	207,861	231,342	23,134	23,134	231,342	8,964,952	10,740,013	12,160,584	13,104,698
2098	175,449	34,739	210,188	233,932	23,393	23,393	233,932	9,140,401	10,950,200	12,394,515	12,870,767
2099	177,413	35,128	212,541	236,550	23,655	23,655	236,550	9,317,814	11,162,741	12,631,066	12,634,216
2100	179,399	35,521	214,920	239,198	23,920	23,920	239,198	9,497,212	11,377,660	12,870,264	12,395,018
2101	181,407	35,919	217,326	241,876	24,188	24,188	241,876	9,678,619	11,594,986	13,112,140	12,153,142
2102	183,438	36,321	219,759	244,584	24,458	24,458	244,584	9,862,057	11,814,745	13,356,724	11,908,558
2103	185,491	36,727	222,219	247,322	24,732	24,732	247,322	10,047,549	12,036,963	13,604,046	11,661,236
2104	187,568	37,138	224,706	250,090	25,009	25,009	250,090	10,235,116	12,261,669	13,854,136	11,411,146
2105	189,667	37,554	227,222	252,890	25,289	25,289	252,890	10,424,784	12,488,891	14,107,026	11,158,256
2106	191,791	37,975	229,765	255,721	25,572	25,572	255,721	10,616,575	12,718,656	14,362,747	10,902,535
2107	193,938	38,400	232,337	258,584	25,858	25,858	258,584	10,810,512	12,950,994	14,621,331	10,643,951
2108	196,109	38,830	234,938	261,478	26,148	26,148	261,478	11,006,621	13,185,932	14,882,809	10,382,473
2109	198,304	39,264	237,568	264,405	26,441	26,441	264,405	11,204,925	13,423,500	15,147,214	10,118,068
2110	200,524	39,704	240,228	267,365	26,737	26,737	267,365	11,405,449	13,663,728	15,414,580	9,850,702
2111	202,769	40,148	242,917	270,358	27,036	27,036	270,358	11,608,218	13,906,645	15,684,938	9,580,344
2112	205,039	40,598	245,636	273,385	27,338	27,338	273,385	11,813,256	14,152,281	15,958,323	9,306,959
2113	207,334	41,052	248,386	276,445	27,645	27,645	276,445	12,020,590	14,400,667	16,234,768	9,030,514
2114	209,655	41,512	251,166	279,540	27,954	27,954	279,540	12,230,245	14,651,833	16,514,308	8,750,974
2115	212,002	41,976	253,978	282,669	28,267	28,267	282,669	12,442,247	14,905,811	16,796,977	8,468,305
2116	214,375	42,446	256,821	285,833	28,583	28,583	285,833	12,656,622	15,162,633	17,082,810	8,182,472
2117	216,775	42,921	259,696	289,033	28,903	28,903	289,033	12,873,396	15,422,329	17,371,843	7,893,439
2118	219,201	43,402	262,603	292,269	29,227	29,227	292,269	13,092,598	15,684,932	17,664,112	7,601,170
2119	221,655	43,888	265,543	295,540	29,554	29,554	295,540	13,314,253	15,950,475	17,959,652	7,305,630
2120	224,137	44,379	268,516	298,849	29,885	29,885	298,849	13,538,390	16,218,991	18,258,501	7,006,781
2121	226,646	44,876	271,522	302,194	30,219	30,219	302,194	13,765,035	16,490,512	18,560,695	6,704,587
2122	229,183	45,378	274,561	305,577	30,558	30,558	305,577	13,994,218	16,765,074	18,866,272	6,399,010
2123	231,748	45,886	277,635	308,998	30,900	30,900	308,998	14,225,967	17,042,708	19,175,270	6,090,012
2124	234,343	46,400	280,743	312,457	31,246	31,246	312,457	14,460,309	17,323,451	19,487,727	5,777,555
2125	236,966	46,919	283,885	315,955	31,595	31,595	315,955	14,697,275	17,607,336	19,803,682	5,461,600
2126	239,619	47,445	287,063	319,492	31,949	31,949	319,492	14,936,894	17,894,399	20,123,173	5,142,109
2127	242,301	47,976	290,277	323,068	32,307	32,307	323,068	15,179,195	18,184,676	20,446,241	4,819,041
2128	245,014	48,513	293,526	326,685	32,668	32,668	326,685	15,424,209	18,478,202	20,772,926	4,492,356
2129	247,756	49,056	296,812	330,342	33,034	33,034	330,342	15,671,965	18,775,014	21,103,268	4,162,014
2130	250,530	49,605	300,135	334,040	33,404	33,404	334,040	15,922,495	19,075,149	21,437,308	3,827,974
2131	253,334	50,160	303,495	337,779	33,778	33,778	337,779	16,175,829	19,378,643	21,775,087	3,490,195
2132	256,170	50,722	306,892	341,560	34,156	34,156	341,560	16,431,999	19,685,535	22,116,647	3,148,635
2133	259,038	51,290	310,327	345,384	34,538	34,538	345,384	16,691,037	19,995,863	22,462,031	2,803,251
2134	261,938	51,864	313,801	349,250	34,925	34,925	349,250	16,952,975	20,309,664	22,811,281	2,454,001
2135	264,870	52,444	317,314	353,160	35,316	35,316	353,160	17,217,845	20,626,978	23,164,441	2,100,841
2136	267,835	53,031	320,866	357,113	35,711	35,711	357,113	17,485,680	20,947,845	23,521,555	1,743,727
2137	270,833	53,625	324,458	361,111	36,111	36,111	361,111	17,756,513	21,272,303	23,882,666	1,382,616
2138	273,865	54,225	328,090	365,153	36,515	36,515	365,153	18,030,378	21,600,393	24,247,819	1,017,463
2139	276,931	54,832	331,763	369,241	36,924	36,924	369,241	18,307,309	21,932,157	24,617,060	648,222
2140	280,031	55,446	335,477	373,375	37,337	37,337	373,375	18,587,340	22,267,634	24,990,435	274,847
2141	283,166	56,067	339,233	377,554	37,755	37,755	377,554	18,870,506	22,606,866	25,367,989	0

Notes:

- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values from OFM 2020-2050 Mid-Growth Projections thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3] Assume soil mass is approximately 10 percent of annual waste volume.
- [4] Total Landfill Mass: [2] + [3].
- [5] Waste volume assuming a density shown in table (lb/cy).
- [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8] Total Landfill Volume: [5] + [6].
- [9] Accumulative waste mass tonnages for the landfill.
- [10] Accumulative total landfill mass in tons.
- [11] Accumulative total landfill volume in cubic yards.
- [12] Remaining capacity.
- [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

**Projected Site Life
Horn Rapids Landfill Expansion**

Waste Yearly Increase (Before 2050)	Waste Density (lb/cy)	Soil Mass by Percent of Refuse	Added Waste (Ton)	Year of Addition	Estimated % Organics Diversion
5.19%	1,200	10%	0	0	10%

High Rate Increase - 1,200lb/cy Compaction with 10% Organics Removal

Added Site Life by 10% Diversion of Organics (Years): 2

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Year	Recorded Disp. Waste (Tons)	Estimated Soil Cover (Tons)	Total Mass (Tons)	Calculated Waste Volume (Cubic Yards)	Calculated Soil Volume (Cubic Yards)	Estimated Organics Diversion (Cubic Yards)	Total Yearly Volume (Cubic Yards)	Accumulative Waste Mass (Tons)	Accumulative Total Mass (Tons)	Accumulative Total Volume (Cubic Yards)	Remaining Capacity (Cubic Yards)
2020	51,541	12,756	64,297	85,901	8,590		94,491	51,541	64,297	94,491	25,170,791
2021	74,462	18,429	92,891	124,103	12,410		136,514	74,462	92,891	231,005	25,034,277
2022	92,699	22,943	115,642	154,498	15,450		169,948	92,699	115,642	400,953	24,864,329
2023	82,185	20,341	102,526	136,975	13,698		150,673	174,884	218,168	551,626	24,713,656
2024	86,447	21,396	107,843	144,079	14,408	14,408	144,079	261,332	326,011	695,705	24,569,577
2025	90,931	22,505	113,436	151,551	15,155	15,155	151,551	352,262	439,447	847,256	24,418,026
2026	95,646	23,672	119,319	159,410	15,941	15,941	159,410	447,908	558,766	1,006,667	24,258,615
2027	100,606	24,900	125,507	167,677	16,768	16,768	167,677	548,515	684,272	1,174,344	24,090,938
2028	105,824	26,191	132,015	176,373	17,637	17,637	176,373	654,339	816,288	1,350,717	23,914,565
2029	111,312	27,550	138,862	185,520	18,552	18,552	185,520	765,651	955,150	1,536,237	23,729,045
2030	117,085	28,978	146,063	195,141	19,514	19,514	195,141	882,736	1,101,213	1,731,379	23,533,903
2031	123,157	30,481	153,638	205,261	20,526	20,526	205,261	1,005,892	1,254,851	1,936,640	23,328,642
2032	129,544	32,062	161,606	215,906	21,591	21,591	215,906	1,135,436	1,416,457	2,152,546	23,112,736
2033	136,262	33,725	169,987	227,103	22,710	22,710	227,103	1,271,698	1,586,443	2,379,649	22,885,633
2034	143,328	35,474	178,802	238,881	23,888	23,888	238,881	1,415,026	1,765,246	2,618,530	22,646,752
2035	150,762	37,313	188,075	251,269	25,127	25,127	251,269	1,565,788	1,953,321	2,869,799	22,395,483
2036	158,580	39,249	197,829	264,300	26,430	26,430	264,300	1,724,368	2,151,149	3,134,099	22,131,183
2037	166,804	41,284	208,088	278,007	27,801	27,801	278,007	1,891,172	2,359,237	3,412,106	21,853,176
2038	175,455	43,425	218,880	292,424	29,242	29,242	292,424	2,066,627	2,578,117	3,704,530	21,560,752
2039	184,554	45,677	230,231	307,589	30,759	30,759	307,589	2,251,180	2,808,347	4,012,120	21,253,162
2040	194,125	48,046	242,171	323,541	32,354	32,354	323,541	2,445,305	3,050,518	4,335,661	20,929,621
2041	204,192	50,538	254,730	340,320	34,032	34,032	340,320	2,649,497	3,305,248	4,675,981	20,589,301
2042	214,781	53,158	267,940	357,969	35,797	35,797	357,969	2,864,278	3,573,187	5,033,950	20,231,332
2043	225,920	55,915	281,835	376,534	37,653	37,653	376,534	3,090,199	3,855,023	5,410,483	19,854,799
2044	237,636	58,815	296,451	396,061	39,606	39,606	396,061	3,327,835	4,151,474	5,806,544	19,458,738
2045	249,960	61,865	311,825	416,600	41,660	41,660	416,600	3,577,795	4,463,300	6,223,145	19,042,137
2046	262,923	65,074	327,997	438,205	43,821	43,821	438,205	3,840,719	4,791,296	6,661,350	18,603,932
2047	276,559	68,448	345,007	460,931	46,093	46,093	460,931	4,117,277	5,136,303	7,122,281	18,143,001
2048	290,901	71,998	362,899	484,835	48,483	48,483	484,835	4,408,178	5,499,202	7,607,116	17,658,166
2049	305,987	75,732	381,719	509,979	50,998	50,998	509,979	4,714,165	5,880,921	8,117,095	17,148,187
2050	321,856	79,659	401,515	536,426	53,643	53,643	536,426	5,036,021	6,282,436	8,653,521	16,611,761
2051	338,547	83,790	422,338	564,245	56,425	56,425	564,245	5,374,568	6,704,774	9,217,766	16,047,516
2052	356,104	88,136	444,240	593,507	59,351	59,351	593,507	5,730,673	7,149,014	9,811,274	15,454,008
2053	374,572	92,707	467,279	624,287	62,429	62,429	624,287	6,105,245	7,616,293	10,435,560	14,829,722
2054	393,998	97,514	491,512	656,663	65,666	65,666	656,663	6,499,242	8,107,805	11,092,223	14,173,059
2055	414,430	102,572	517,002	690,717	69,072	69,072	690,717	6,913,673	8,624,807	11,782,940	13,482,342
2056	435,923	107,891	543,814	726,538	72,654	72,654	726,538	7,349,595	9,168,620	12,509,478	12,755,804
2057	458,530	113,486	572,016	764,216	76,422	76,422	764,216	7,808,125	9,740,636	13,273,695	11,991,587
2058	482,309	119,372	601,681	803,849	80,385	80,385	803,849	8,290,435	10,342,317	14,077,544	11,187,738
2059	507,322	125,562	632,884	845,537	84,554	84,554	845,537	8,797,757	10,975,202	14,923,080	10,342,202
2060	533,632	132,074	665,706	889,387	88,939	88,939	889,387	9,331,389	11,640,907	15,812,467	9,452,815
2061	561,306	138,923	700,230	935,510	93,551	93,551	935,510	9,892,695	12,341,137	16,747,977	8,517,305
2062	590,416	146,128	736,544	984,026	98,403	98,403	984,026	10,483,111	13,077,681	17,732,004	7,533,278
2063	621,035	153,706	774,741	1,035,058	103,506	103,506	1,035,058	11,104,146	13,852,422	18,767,062	6,498,220
2064	653,242	161,677	814,919	1,088,736	108,874	108,874	1,088,736	11,757,387	14,667,341	19,855,798	5,409,484
2065	687,119	170,062	857,181	1,145,199	114,520	114,520	1,145,199	12,444,507	15,524,522	21,000,997	4,264,285
2066	722,753	178,881	901,635	1,204,589	120,459	120,459	1,204,589	13,167,260	16,426,157	22,205,586	3,059,696
2067	760,236	188,158	948,394	1,267,059	126,706	126,706	1,267,059	13,927,496	17,374,551	23,472,645	1,792,637
2068	799,662	197,916	997,578	1,332,769	133,277	133,277	1,332,769	14,727,157	18,372,128	24,805,414	459,868
2069	841,132	208,180	1,049,312	1,401,887	140,189	140,189	1,401,887	15,568,289	19,421,441	26,207,301	0

Notes:

- [1] Year that the solid waste was deposited. Assumed 3/4 the waste in 2020 was placed in Phase 1 following its construction in the first quarter of 2020.
- [2] Recorded waste tonnages provided by the City of Richland from 2020-2022 (shown in bold). Assumes an annual increase rate based on historical waste values thereafter. Recorded waste for 2022 considered an outlier; therefore, rate applied to 2021 tonnage for 2023 projection.
- [3] Assume soil mass is approximately 10 percent of annual waste volume.
- [4] Total Landfill Mass: [2] + [3].
- [5] Waste volume assuming a density shown in table (lb/cy).
- [6] Calculated Soil Volume = Soil percent x [5]. Assume daily cover is based on a percentage of the waste volume.
- [7] Estimated Organics Diversion = Percent organics diversion x [5]. Assumes percentage of total waste volume removed by diverting organics beginning in 2024.
- [8] Total Landfill Volume: [5] + [6].
- [9] Accumulative waste mass tonnages for the landfill.
- [10] Accumulative total landfill mass in tons.
- [11] Accumulative total landfill volume in cubic yards.
- [12] Remaining capacity.
- [13] Assume each phase is filled to the end of the year. The next phase will be prepared for filling while the previous phase is being filled.

lb/ton	Soil Density (lb/cy)
2,000	2,970

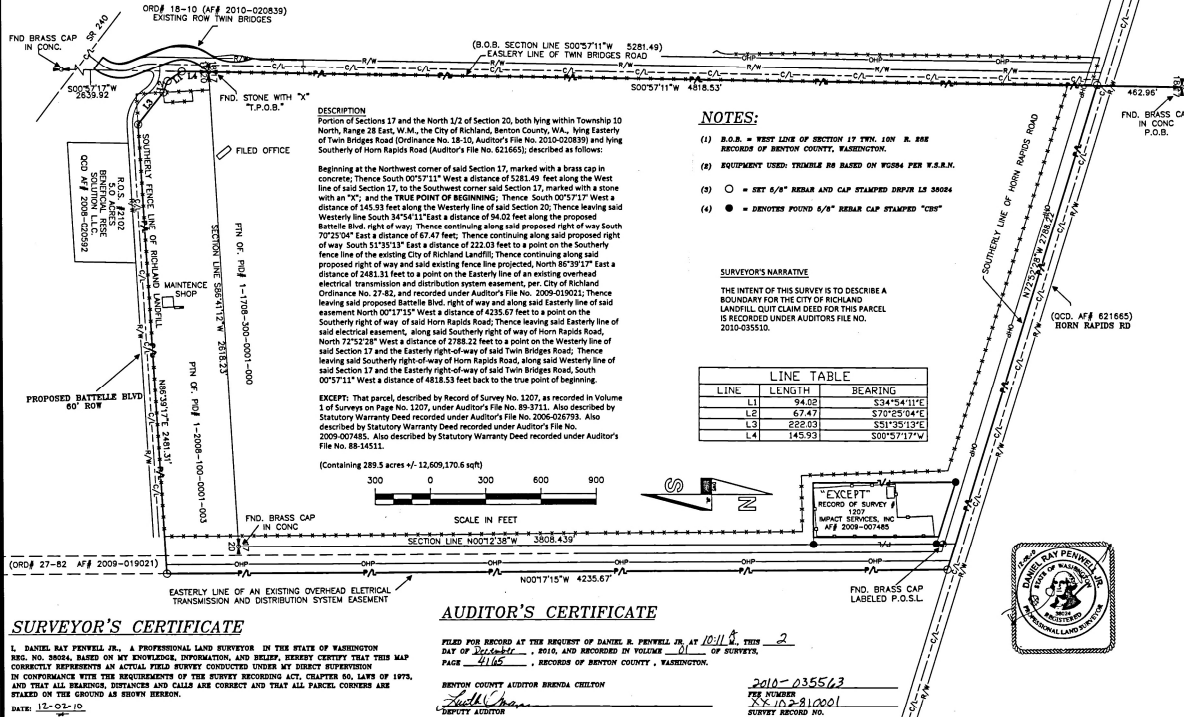
Attachment 4

Landfill Record of Survey



RECORD of SURVEY No. 4165

PORTION OF SEC. 17 & 20, TWN. 10N., R. 28E., W.M.,
CITY OF RICHLAND,
BENTON COUNTY, WASHINGTON.





Organic Solid Waste Collection and Processing

Utility Advisory Committee

May 9, 2023



House Bill 1799 – 2022 State Legislation Policy Goals

- Seeks to divert organic wastes from landfill disposal
 - Means to climate change mitigation against uncontrolled methane emissions
- Sets goal of 75% reduction in statewide organics disposal by 2030 relative to 2015 disposal rates
- Sets goal of at least 20% of wasted food be recovered for human consumption by 2025



House Bill 1799 – 2022 State Legislation Solid Waste Operations Requirements

- Source-separated organic waste collection provided to all residents by 1/1/2027
- Source-separated organic waste collection available to non-residential customers who generate minimum quantity of organic waste by 1/1/2027
- All collected organic material must be managed through “organic materials management”



House Bill 1799 – 2022 State Legislation Organic Materials Management

- Organic materials management includes:
 - Composting
 - Anaerobic Digestion
 - Vermiculture
 - Black soldier fly
 - Similar technologies

House Bill 1799 – 2022 State Legislation Waiver of Operating Requirements

- Department of Ecology tasked with developing waiver program
- Waiver period limited to five years
- Waiver criteria
 - Distance to organic material management facilities
 - Organic material management facilities capacity limitations
 - Ecology may adopt rules governing qualification for waiver

House Bill 1799 – 2022 State Legislation Business Obligations

- Annual Department of Ecology determination of organic collection and materials management service availability in counties
- Upon determination of service availability businesses must subscribe to organics collection and material management services



Richland's Standing Relative to HB 1799 Requirements

- Organics collection (yard waste) available to all residential properties
 - No food waste disposal permitted
- No organics collection available to non-residential customers
- Composting of collected yard waste
- No organic material management for food waste
- Partial compliance with collection requirements



Richland's Standing Relative to Organic Material Management

- No planned or operational anaerobic digester for food waste in region
 - Richland Wastewater Treatment Plant includes anaerobic digestion process for on-site biosolids
 - Pasco contracted with private developer for anaerobic digester and renewable natural gas plant on industrial wastewater system
- Richland renewable natural gas plant scheduled to be operational in late 2023 (conditioning landfill gas)

Planning Approach Options

- Seek coverage under Ecology waiver program until organic material management capability develops in region
- Explore opportunities to develop organic material management capability for Richland needs
- Explore opportunities to develop organic material management capability for regional use
- Other



Solid Waste Regional Services

Utility Advisory Committee

September 12, 2023

Objectives

- Discuss strategic approach to landfill capacity
- Discuss strategic approach to organics collection and processing

Landfill Capacity / Costs

- Existing permitted capacity predicted to last approx. 60 years
- Feasibly expansion on the same parcel could extend capacity another 15 – 20 years
- Disposal costs - \$25 / ton
- Regional disposal costs - \$45 – 50 / ton
- Does this represent an opportunity to extend services to the region?

Organics Collection and Processing

- City must provide source separated organics collection to residential and business customers
- Many businesses must secure organics diversion services
- Limited term waivers available if material processing not available
- Should Richland explore feasibility of siting an organics processing facility at or near the landfill?

Related Questions

- How much landfill capacity is enough?
- How will solid waste be disposed of once Horn Rapids Landfill capacity is exhausted?
- How long will landfiling be the best disposal option?
- Will the landfill be a compatible / desirable use in the Horn Rapids Industrial Park indefinitely?
- Are partnerships available to assist with new facility development?



UTILITY ADVISORY COMMITTEE AGENDA ITEM COVERSHEET

Meeting Date: 9/12/2023

Agenda Category: Other Informational Items

Prepared By: Clint Whitney, Energy Services Director

Subject:

Capital Work Plan Update - August 2023

Department:

Energy Services

Recommended Motion:

This is an informational item only.

Summary:

The 2023 Capital Work Plan (CWP) has an approved budget of \$11.1M. The CWP significant areas of capital work include: Advanced Metering Infrastructure (AMI), System Improvements, Renewal & Replacements, Substation Improvements, and Line Extensions. Capital plans are influenced by reliability data and areas of economic development. Capital work is funded from electric rate revenue and revenue bonds. Attached is a summary of the 2023 CWP through August.

While CWP expenditures through August are 36% of the approved budget, the 2023 CWP is planned with more expenditures in late third and fourth quarter of the year. Associated costs include engineering design for Stevens and Thayer Substation, underground cable replacement for the Richland Airport, as well as the delivery of the Metalclad Switchgear and construction of City View Bank #2 addition. The support of line extensions to new developments or construction is approximately 1/3 of the yearly expected work and which aligns with a substantial slow down in residential and commercial construction permit applications.

Capital investments maintain and improve electrical distribution infrastructure to ensure continued support for reliable electric service, economic development, and a safe system while balancing costs.

Fiscal Impact:

None.

Attachments:

- I. RES CWP REPORT-August 2023



Richland Energy Services Capital Work Plan August 2023



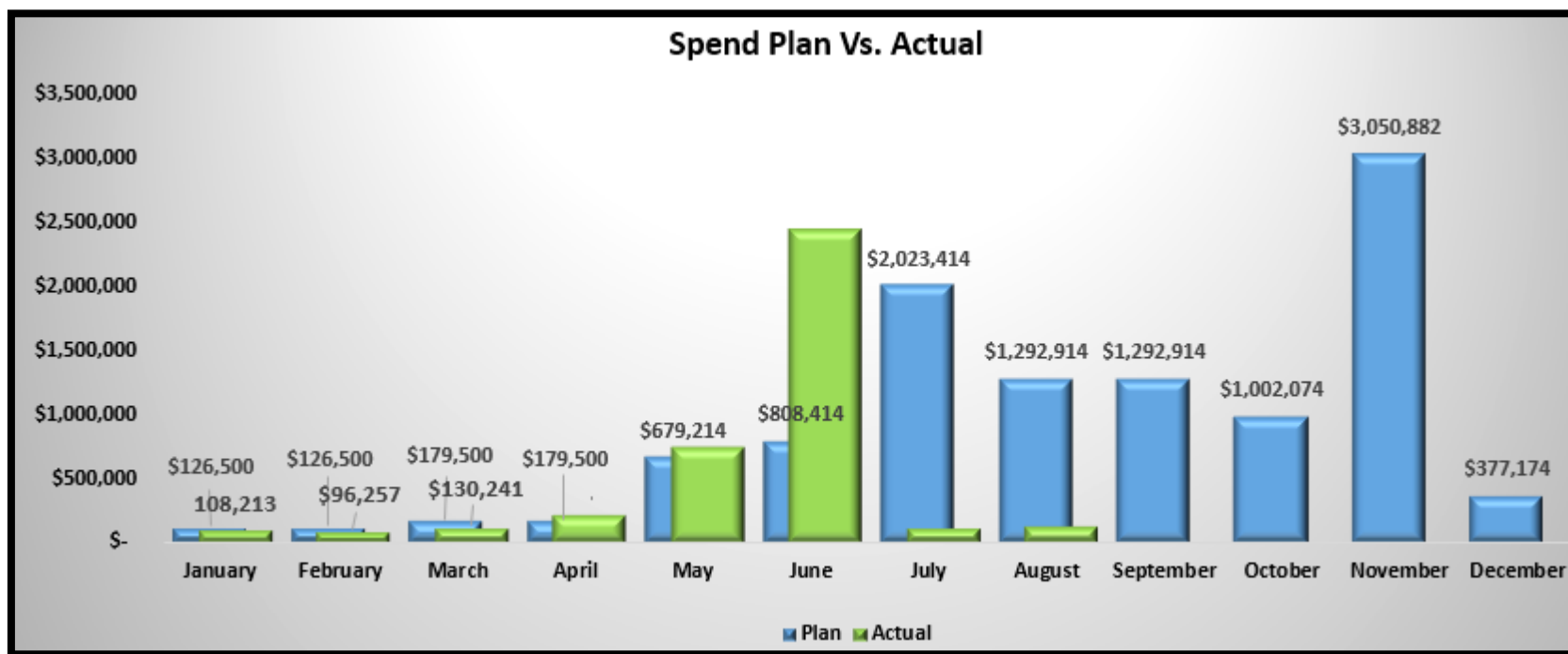
CWP Costs for August

	Approved 2023 Budget	2023 Estimated Costs	Actual	Remaining	August
+ Line Extensions	\$2,120,000	\$ 2,120,000	\$ 727,537	\$ 1,392,463	\$ 7,031
+ System Improvements	\$1,028,000	\$ 1,028,000	\$ 579,697	\$ 448,303	\$ 113,247
+ Renewal and Replacement	\$3,198,000	\$ 3,198,000	\$ 273,179	\$ 2,924,821	\$ 15,397
+ Purchase Southwest Service Area Infrastructure	\$212,000	\$ 212,000	\$ -	\$ 212,000	\$ -
- Substation Improvements	\$4,581,000	\$ 4,581,000	\$ 2,454,883	\$ 2,126,117	\$ 4,823
+ Substation Improvements	\$4,581,000	\$ 4,581,000	\$ 2,454,883	\$ 2,126,117	\$4,822.81
Grand Total	\$11,139,000	\$ 11,139,000	\$ 4,035,295	\$ 7,103,705	\$140,498

Cost Performance YTD:	\$4,035,295
Cost Performance remaining:	\$7,103,705
YTD % Complete	36%

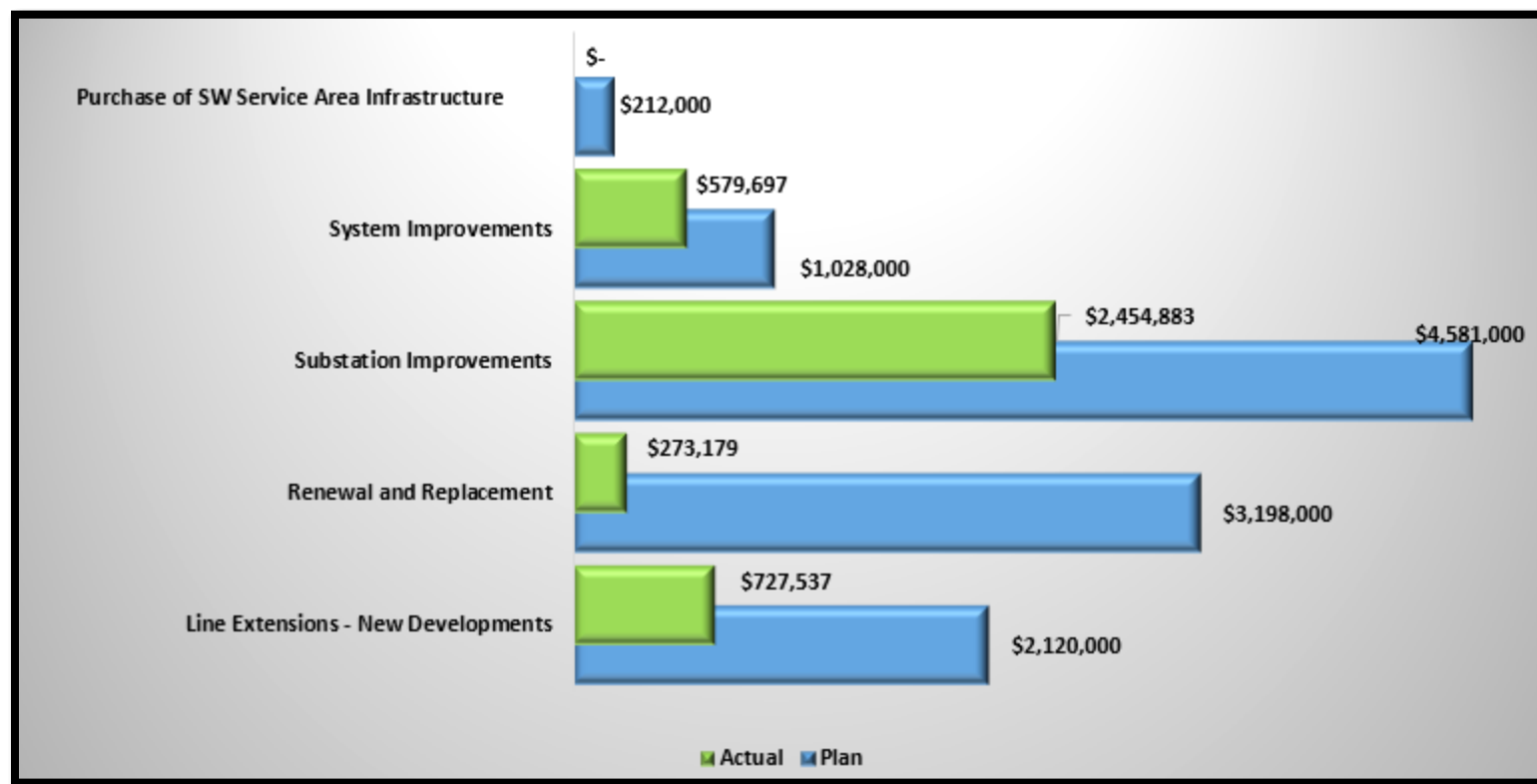


CWP Monthly Spend Vs. Actuals



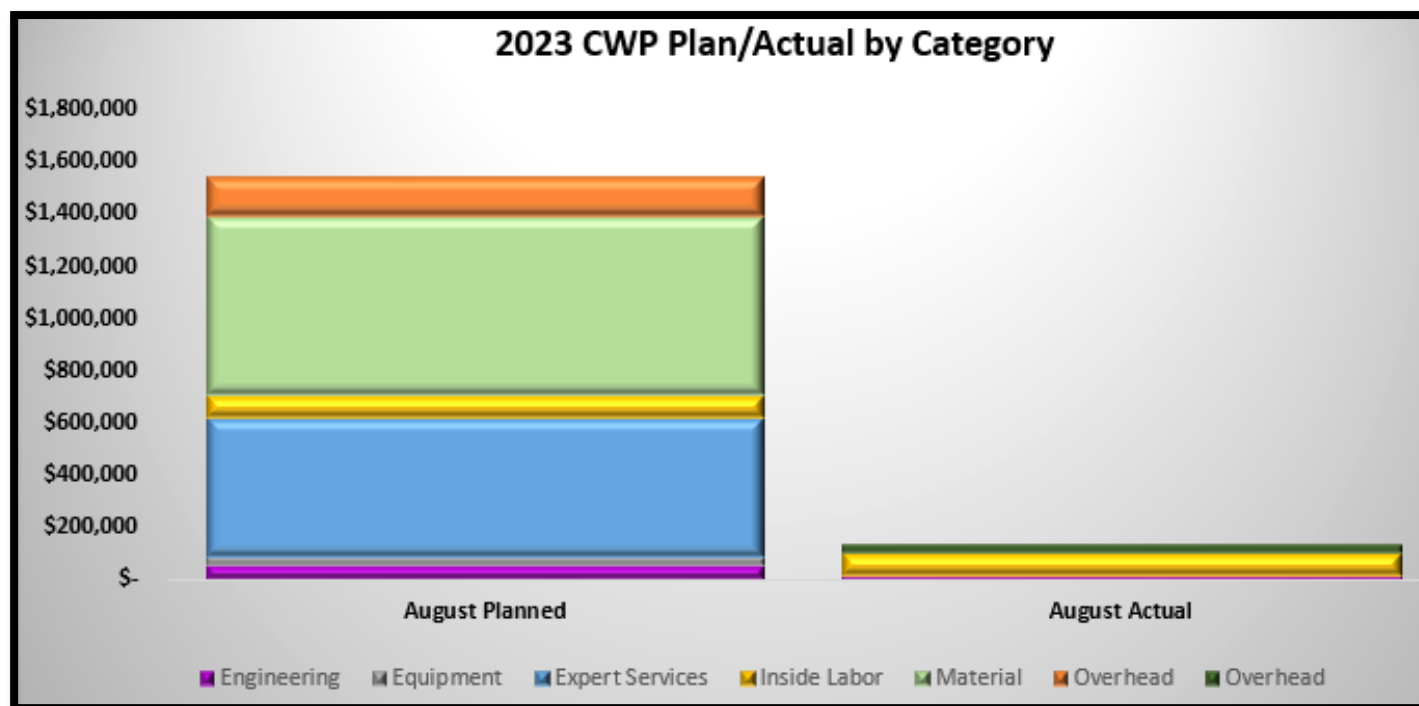
% Complete of Overall Spend Plan		
To-Date Projected	\$	5,415,956
To-Date Actual	\$	4,035,295
Variance	(\$1,380,661)	75%

Costs by Category





CWP Cost Types



Cost Type	August Planned	August Actual
Engineering	\$ 61,517	\$ 14,748
Equipment	\$ 25,012	\$ -
Expert Service	\$ 537,727	\$ -
Inside Labor	\$ 87,419	\$ 87,239
Material	\$ 424,606	\$ 3,485
Overhead	\$ 156,633	\$ 31,295
Total	\$ 1,292,914	\$ 136,767



CWP Project Costs for August

	Approved 2023 Budget	2023 Estimated Costs	Actual	Remaining	August
✚ Line Extensions	\$2,120,000	\$ 2,120,000	\$ 727,537	\$ 1,392,463	\$ 7,031
✚ System Improvements	\$1,028,000	\$ 1,028,000	\$ 579,697	\$ 448,303	\$ 113,247
✚ METER INSTALLATION MATERIALS	\$0	\$ -	\$ 297,127	\$ (297,127)	\$63,933.91
✚ NEW & ALT SVCS - UNDERGROUND	\$498,000	\$ 498,000	\$ 213,221	\$ 284,779	\$45,050.59
✚ RES OH UG ENG DESIGN DWGS	\$0	\$ -	\$ 11,930	\$ (11,930)	\$1,347.43
✚ SKYLINE DR DEVELOPMENT; NEW PRIMARY AND SECONDARY	\$0	\$ -	\$ 9,643	\$ (9,643)	\$0.00
✚ Fusion Substation Transmission Line	\$530,000	\$ 530,000	\$ -	\$ 530,000	\$0.00
✚ Constuction Assembly Standards	\$0	\$ -	\$ 27,835	\$ (27,835)	\$2,915.46
✚ 1663 Fowler, Relocate Aprox 550ft 3 750MCM out of easement	\$0	\$ -	\$ 19,941	\$ (19,941)	\$0.00
✚ Renewal and Replacement	\$3,198,000	\$ 3,198,000	\$ 273,179	\$ 2,924,821	\$ 15,397
✚ First Street Re-Gasket	\$0	\$ -	\$ 330	\$ (330)	\$0.00
✚ 2022 Primary Cable Testing - NEETRAC	\$0	\$ -	\$ -	\$ -	\$0.00
✚ Thayer Substation - Bank 1 Rebuild and 115kV Bus Overhaul	\$318,000	\$ 318,000	\$ 12,049	\$ 305,951	\$1,348.68
✚ Stevens Substation - Bank 1 Rebuild and 115kV Bus Overhaul	\$318,000	\$ 318,000	\$ 19,782	\$ 298,218	\$1,170.81
✚ 2023 Pole Replacement Program	\$646,000	\$ 646,000	\$ -	\$ 646,000	\$0.00
✚ 1937 Forest, RR old 1-0AL and move XFR to Street	\$0	\$ -	\$ 839	\$ (839)	\$839.25
✚ Pole Replacement Program					
✚ 1412 RICHE CT; RENEW/REPLACE OH SYSTEM	\$0	\$ -	\$ 26,276	\$ (26,276)	\$11,137.91
✚ UG Cable Replacement					
✚ 1902 Airport Way, Renew Replace Boring Contract Richland Airport	\$1,916,000	\$ 1,916,000	\$ 5,889	\$ 1,910,111	\$900.32
✚ 2500 GWW, R and R UG Prim for Apt complex, ILLAHEE Apts, 2023 Boring	\$0	\$ -	\$ 208,014	\$ (208,014)	\$0.00
✚ Purchase Southwest Service Area Infrastructure	\$212,000	\$ 212,000	\$ -	\$ 212,000	\$ -
✚ Substation Improvements	\$4,581,000	\$ 4,581,000	\$ 2,454,883	\$ 2,126,117	\$ 4,823
✚ Demand Response by Voltage Reduction (DR by VR)	\$0	\$ -	\$ 630	\$ (630)	\$0.00
✚ Gateway Substation 2021 Project	\$0	\$ -	\$ 6,896	\$ (6,896)	\$1,556.77
✚ City View Bank 2 Addition	\$4,293,000	\$ 4,293,000	\$ 2,444,033	\$ 1,848,967	\$3,266.04
✚ City View Extension 131, EXT 3P 750 Aprox 2000ft from Cityview to Kenn	\$288,000	\$ 288,000	\$ 918	\$ 287,082	\$0.00
✚ Substation PLC Replacement (Sandhill Crane, City View, and Richland Sv	\$0	\$ -	\$ 2,406	\$ (2,406)	\$0.00
Grand Total	\$11,139,000	\$ 11,139,000	\$ 4,035,295	\$ 7,103,705	\$140,498