From:	Ken Eklund
To:	REDICK Daniel
Cc:	Sam Imperati; Benton County Talks Trash
Subject:	Re: BCTT Subcommittee Meeting #7 - A.1. Landfill Size/Capacity/Longevity
Date:	Monday, January 2, 2023 12:05:07 AM
Attachments:	Master Working Document Subcomm A1 Report V3KE 12-29-22.docx

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Daniel,

Here are my edits so far to the A1 Subcommittee's draft document, in Word format, for you to crash together with other edits to produce our next working draft – in advance of our Tuesday meeting. Whew. Thanks! – Ken

Ken Eklund, writerguy

Creator of
World Without Oil
Ed Zed Omega
FutureCoast
and other storymaking games

> On Dec 7, 2022, at 4:31 PM, REDICK Daniel <daniel.redick@Co.Benton.OR.US> wrote:
>
> Greetings BCTT A.1. Landfill Size/Capacity/Longevity Subcommittee,
>
> Please join our 7th subcommittee meeting:
>
> - Meeting #7: January 3, 10:30 – 12:00 PM Pacific Time (Zoom Meeting Details Below)
>
> The agenda and supporting documents will be added subcommittee webpage ahead of each meeting.
>
> Zoom Meeting Details:
>
> Benton County Community Development is inviting you to a scheduled Zoom meeting.
>
> Topic: BCTT Subcommittee Meeting #7 - A.1. Landfill Size/Capacity/Longevity
> Time: Jan 3, 2023 10:30 AM Pacific Time (US and Canada)

Join Zoom Meeting
https://us06web.zoom.us/j/82847784146

Meeting ID: 828 4778 4146
One tap mobile
+17193594580,,82847784146# US
+17207072699,,82847784146# US (Denver)

Dial by your location
+1 719 359 4580 US
+1 720 707 2699 US (Denver)
+1 253 205 0468 US
+1 253 215 8782 US (Tacoma)
+1 346 248 7799 US (Houston)
+1 669 444 9171 US
+1 386 347 5053 US
+1 507 473 4847 US
+1 564 217 2000 US
+1 646 558 8656 US (New York)
+1 646 931 3860 US
+1 689 278 1000 US
+1 301 715 8592 US (Washington DC)
+1 305 224 1968 US
+1 309 205 3325 US
+1 312 626 6799 US (Chicago)
+1 360 209 5623 US
Meeting ID: 828 4778 4146
Find your local number: https://us06web.zoom.us/u/kbo34t2YM

Best,

<image001.png>

Daniel Redick *he/him*
Solid Waste & Water Quality Program Coordinator
Community Development

Phone: 541-766-6819
Email: daniel.redick@co.benton.or.us

www.co.benton.or.us

Community Development has moved to the Kalapuya Building at 4500 SW Research Way, 2nd Floor.
Come see the new space; we are officially open for business!

<Mail Attachment.ics>

Benton County Solid Waste Process Workgroup

Subcommittee A.1 Landfill Size/Capacity/Longevity

Subcommittee Report to Workgroup

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Table of Contents

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Section 0: Background

A. Charge

i. Workgroup charter and bylaws 8-23-2022

From the Benton County Talks Trash" Workgroup Charter and Bylaws document, Topic A:

A. Develop Common Understandings to form the basis of the work.

1) A chronological history of key Coffin Butte Landfill topics:

a. Size;

b. Specific locations;

c. Conditions of past land use approvals;

d. Compliance with prior land use approvals and SWMP;

e. Reporting requirements;

f. Assumptions (e.g. when will the landfill close;)

g. Economics (i.e. Benefit – Cost, etc.;) and

h. Examples from other jurisdictions hosting landfills, e.g.:

i. Typical land use conditions of approval; and

ii. Issue sequencing, (e.g. in what order are landfill versus hauling approvals done, etc.

ii. Subcommittee A.1 charge

The A.1 subcommittee was charged with a subset of the tasks listed above. Specifically, per the A.1 Subcommittee web page:

Charge A: Common Understandings Tasks

1) A chronological history of key Coffin Butte Landfill topics:

1. Size;
2. Specific locations;
3. Assumptions (e.g. when will the landfill close;)

Thus the A.1 subcommittee addresses components 1(a), 1(b) and 1(f) of the workgroup charter Topic A tasks.

Charge 3 "Assumptions" is interpreted to mean estimation of the landfill operational lifetime including the assumptions behind this estimation.

Note that for the A.1 subcommittee, "chronological history" is limited specifically to these three topics; a more general history of the landfill will be addressed by another body.

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iii. Common Terms

Landfill means a facility for the disposal of solid waste involving the placement of solid waste on or beneath the land surface. ORS 459.005(14)

Sanitary landfills are intended as biological reactors (bioreactors) in which microbes will break down complex organic waste into simpler~~, less toxic~~ compounds over time.

Disposal site means land and facilities used for the disposal, handling or transfer of, or energy recovery, material recovery and recycling from solid wastes, including but not limited to dumps, landfills, sludge lagoons, sludge treatment facilities, disposal sites for septic tank pumping or cesspool cleaning service, transfer stations, energy recovery facilities, incinerators for solid waste delivered by the public or by a collection service, composting plants and land and facilities previously used for solid waste disposal at a land disposal site. ORS 459.005 (8)

Regional disposal site means a disposal site that receives, or a proposed disposal site that is designed to receive more than 75,000 tons of solid waste a year from outside the immediate service area in which the disposal site is located. As used in this subsection, "immediate service area" means the county boundary of all counties except a county that is within the boundary of the metropolitan service district. For a county within the metropolitan service district, "immediate service area" means the metropolitan service district boundary. ORS 459.005 (22)

From all particular measures, a landfill is a subset of a disposal site.

Landfill cell means a discrete volume of a landfill which uses a liner system to provide isolation of solid waste from adjacent cells of solid waste. (RI 250-RICR=140-05-1)

Coffin Butte Landfill is a regional disposal site and an engineered sanitary landfill in Benton County, north of Corvallis, located off Coffin Butte Road.

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B. Membership Composition

The A.1 Subcommittee membership is composed of four primary representative groups:

1. Franchisee: 3 members (Ian Macnab, Ginger Rough, Bill Bromann, all of Republic Services)
2. Benton County members and SWAC & DSAC members: 3 members (Chuck Gilbert, Mark Yeager, Ken Eklund)
3. County governments: 3 members (Daniel Redick (Benton County), Brian May (Marion County), Shane Sanderson (Linn County))
4. Private citizens: 1 member (Paul Nietfeld)

Daniel Redick, a Benton County Community Development Department staff member, acts as Chair of this subcommittee.

Sam Imperati, the workgroup facilitator, normally attends subcommittee meetings and provides guidance in regard to aligning with workgroup objectives.

C. Document Organization

This document is organized into sections that correspond to the “Charge” items assigned to the A.1 Subcommittee (i.e. Sections 1, 2, 3 correspond to Charges 1, 2, 3).

References to specific sections in this document are in the format <Section #>.<Subsection Letter>.<Subpart Designation>. Thus this location would be referenced as 0.C, and the A.1 Subcommittee Charge may be found in 0.A.ii.

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Section 1: Landfill Size

A. Physical Real Estate Footprint

Other topics required in addition to those noted below?

i. History

Per the 2002 MOU [Benton County & Valley Landfills MOU Relating to Land Use Issues (2002)](https://):

- 1974 CUP approved landfill activities on 184 acres north of Coffin Butte Road.
- 1983 rezoning added 10 acres for landfill activities north of Coffin Butte Road, for a total of 194 acres.
- Franchisee (VLI) agrees that the approximately 56-acre parcel south of Coffin Butte Road, while zoned LS, would not be used for disposal of solid waste unless approved by a conditional use permit and Department of Enviromental Quailty permit for solid waste landfill use..
- Total acreage owned by landfill franchisee unstated.

Include: snapshots of footprint over time and a table of landfill property area over time.

***DANIEL**: Do you have any historical data on this?*

ii. Current footprint

*Summary of current configuration (total footprint and breakdown by zoning type (acres), specific taxlots with zoning designations, working area of active landfill ("working face" area) to address historic limitations on this parameter (e.g. 1983 CUP: "*not exceed 2 acres during the periods of October 15 to June 1 and to not exceed 3/ 4 of an acre during all other periods.*").*

B. Permitted Disposal Capacity

i. Historical permitted capacity benchmarks

Date	Capacity (yd^3)	Notes
1995	18,000,000	1995 Annual Report, estimated total capacity of Cells 1-5
2003	35,531,000	2003 Site Development Plan, based on October 1999 cell volumes and adding West and East triangles, with Cell 6 estimated at 13,397,000 yd^3
2021	38,997,848	2021 Coffin Butte Annual Report

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ii.

Table 1

Discuss at this point theoretical Cell 6 volume vs. currently available vs. likely scenario? Ian provided guidance recently; is this still valid?

***DANIEL**: Do you have other datapoints that should be included in the table above?*

ii. Capacity utilization TBD – 2021

A plot of available/used capacity over time may be a useful reference. See Daniel's Reported Airspace (2014-2021) plot as an example:

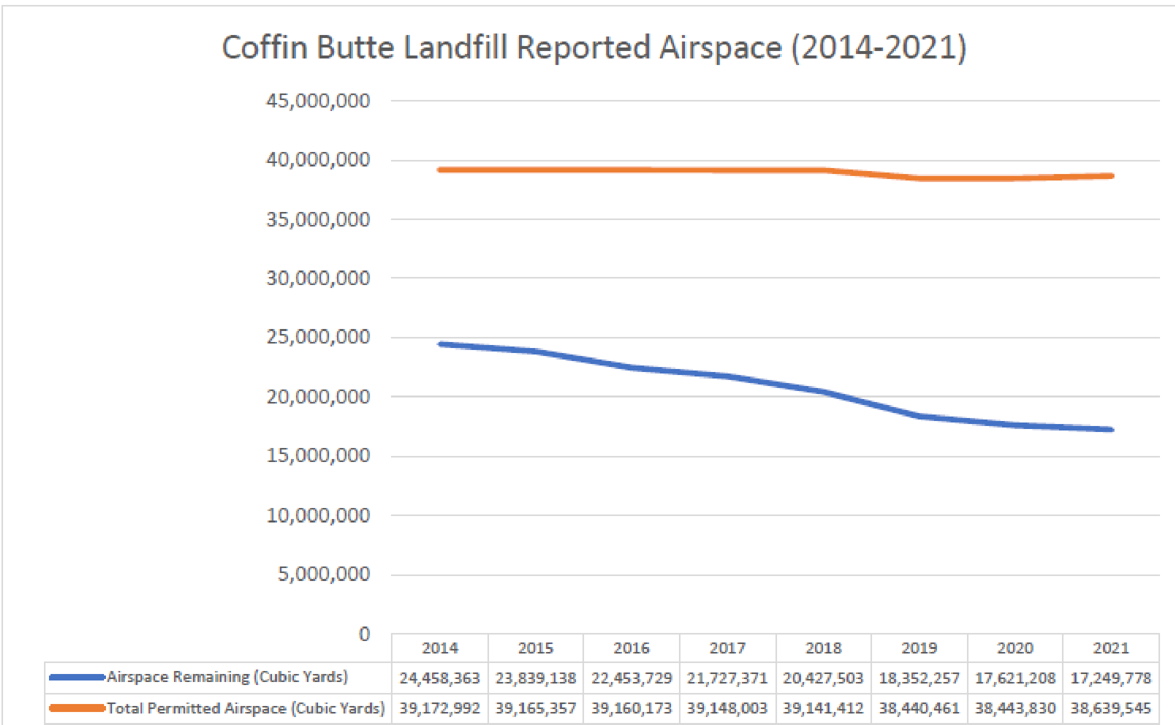

Figure 1

Note that as of end 2021 approximately 44% of permitted capacity remained unused.

iii. Near-term (circa 2025) capacity adjustments for 5-year operating plan

Provide simple overview of Cell 5 -> Cell 6 transition issue in terms that can be understood by the general public. State that as of the time of this report (Q4 2022) potential solutions are being explored? Note this as the driving factor in LU21-047?

***REPUBLIC SERVICES**: guidance/input on phrasing and/or extent to which this should be flagged as an issue.*

C. Intake Volume

Coffin Butte intake volume is documented in the annual reports produced by the landfill franchisee. Benton County has annual reports on file for years 1993 – 2021 (inclusive) with the exception of year 2000; intake data for 2000 is available in the 2021 report. Note that with older (pre-2008) reports, the annual intake volume figure is sometimes difficult to determine precisely due to inconsistent values stated within a given annual report (e.g. narrative summary vs. intake volume table) and/or discrepancies in values referenced in subsequent annual reports (e.g. historical comparisons). Where discrepancies exist within a given annual report, the figure documented in the intake volume table is used. See Appendix A for a detailed listing of the annual intake volumes used in this document.

i. Recent intake volume: 1993 – 2021

Annual intake volume for 1993 – 2021 is shown in Figure 2.

< GRAPHIC EDIT NEEDED: the Fig 2 graphic shows the 2020 FA Limit at 1.2M tons/yr; the correct limit is 1.1M. >

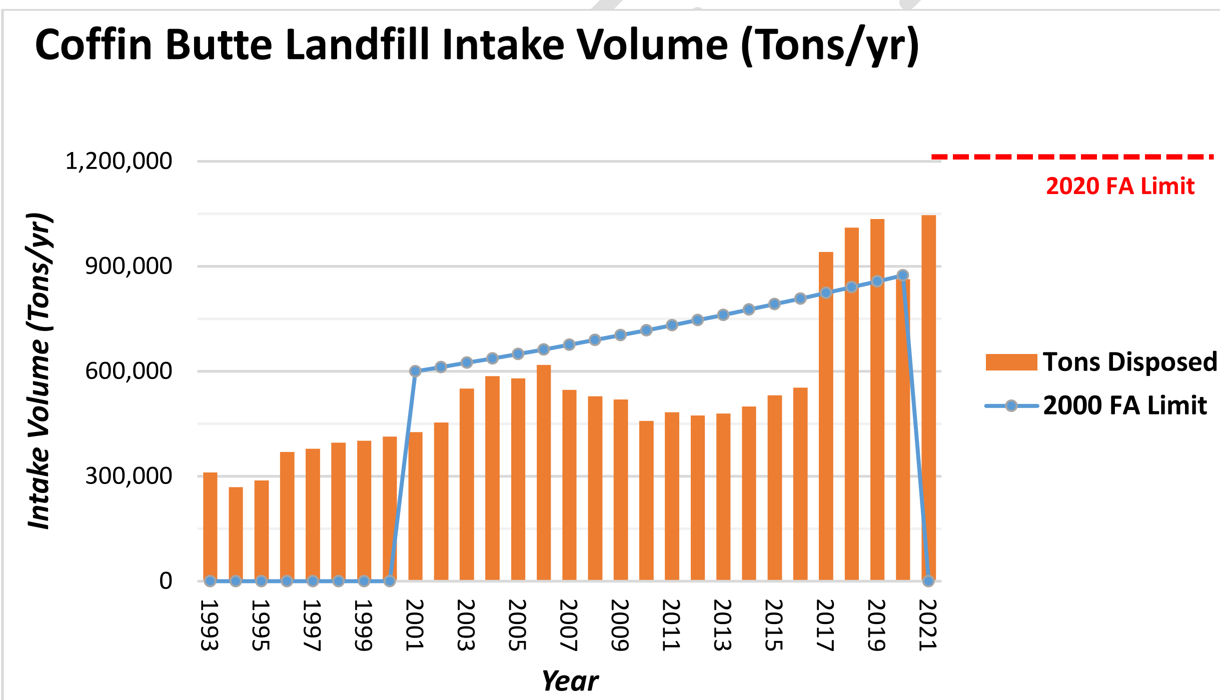

Figure 2

Comments/discussion:

1. The 2000 Landfill Franchise Agreement imposed a ramping intake limit (cap) to be applied during the term of the agreement (CY2001-2019), denoted in the chart by the blue line (“2000 FA Limit”).

2. Due to an expected additional influx of volume in 2017 resulting from the waste flow disruption into Riverbend landfill in Yamhill County, in December 2016 the franchisee and Benton County executed a MOU agreeing to an expected increase in Coffin Butte intake volume "for a term of 1-2 years."
3. In documents provided to the A.1 Subcommittee, representatives of the franchisee have indicated that the approximately 70% year-over-year increase in CY2016-2017 was due to redirected flow from Riverbend to Coffin Butte.
4. The 2020 Landfill Franchise Agreement defined a flat intake limit (cap) of 1.1M Tons/yr. unless expansion was fully permitted onto the "expansion parcel" (i.e. the lot south of Coffin Butte Road zoned LS in 1983 but at that time restricted to non-disposal activities); upon this expansion approval the intake limit would be eliminated. The 2020 intake limit is denoted in the chart by the dashed red line ("2020 FA Limit").
5. The slow downward trend in intake volume in the 2017-2012 period is explained by the franchisee as resulting from the economic downturn of 2008.
6. The decreased intake volume in 2020 is attributed to the Covid-19 outbreak.

ii. Intake volume by source 2016 – 2021

A stacked bar chart may be helpful for a) analyzing the source flow changes that occurred in 2016-2017, and b) addressing questions regarding the extent to which the disruption of inflow to Riverbend accounts for the 2016-2017 increase.

DANIEL *or* ***REPUBLIC SERVICES****: can you supply this chart? Alternatively, data could be extracted from the annual reports.*

iii. Long-term intake volume TBD – 2021

A long-term intake volume plot (from circa early 1980s to present) may be useful, in keeping with the "chronological history" aspect of the A.1 charge, and this could provide useful perspective for all concerned. For reference, in the approximately 80 years of landfill activity to date, 21,389,767 yd^3 have been consumed per the 2021 annual report, for an average volume of about 267,000 yd^3 per year.

This plot will require intake volume data and/or estimates that predate the available annual reports. Paul to investigate; any data input from others would be welcome.

D. Landfill Structure

i. Overview

The disposal area and surrounding lots are shown in Figure 3 below. This drawing is reproduced from the 2021 Site Development Plan, Appendix A, Drawing No. G03, and is reproduced here for convenience.

Drawing below imported from pdf; quality degraded. Better means of importing into Word?

ii. Cell detail

Detail on individual disposal cells and the active dates for these cells is shown in Figure 4 below.

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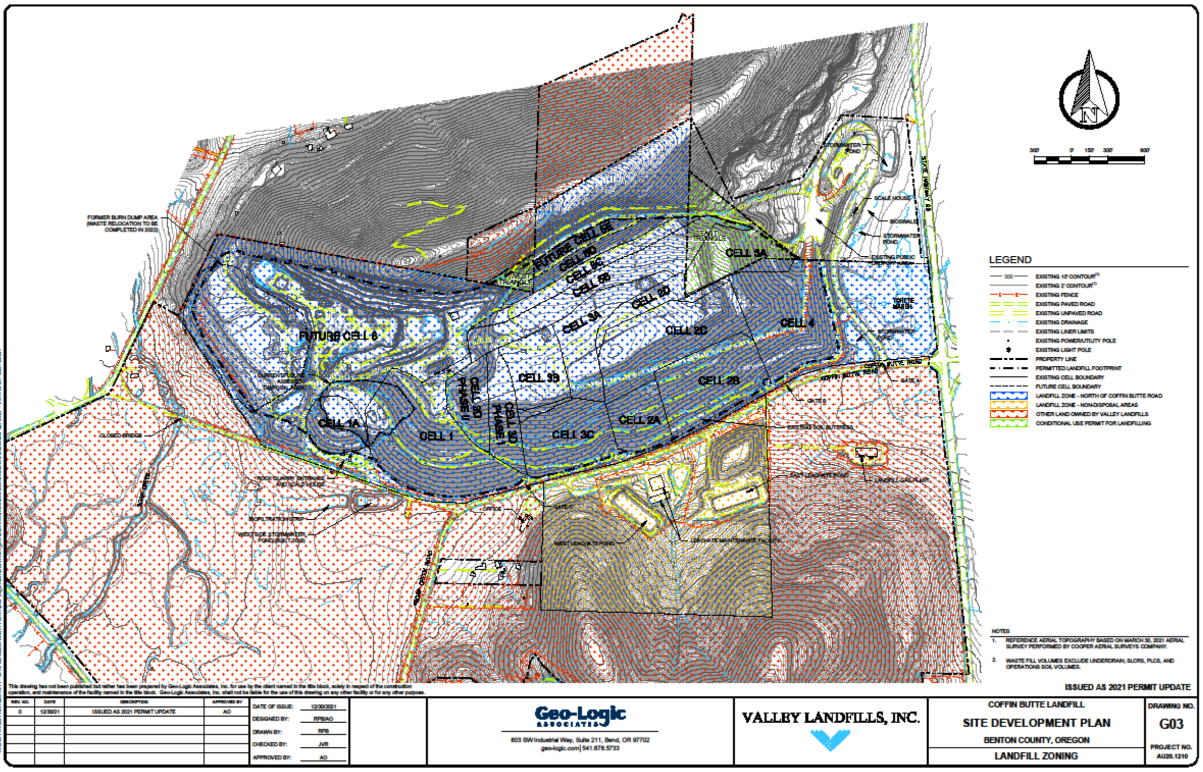

FUTURE CELL 6
CELL 1A
CELL 1
CELL 3C
CELL 3B
CELL 3A
CELL 2A
CELL 2B
CELL 2C
CELL 4
CELL 5A
LEGEND
EXISTING 10' CONTOUR
EXISTING 2' CONTOUR
EXISTING FENCE
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING DRAINAGE
EXISTING LINER LIMITS
EXISTING POWER/UTILITY POLE
EXISTING LIGHT POLE
PROPERTY LINE
PERMITTED LANDFILL FOOTPRINT
EXISTING CELL BOUNDARY
FUTURE CELL BOUNDARY
LANDFILL ZONE - NORTH OF COFFIN BUTTE ROAD
LANDFILL ZONE - NON-DISPOSAL AREAS
OTHER LAND OWNED BY VALLEY LANDFILLS
CONDITIONAL USE PERMIT FOR LANDFILLING
NOTES
1. REFERENCE AERIAL TOPOGRAPHY BASED ON MARCH 30, 2021 AERIAL SURVEY PERFORMED BY COOPER AERIAL SURVEYS COMPANY.
2. WASTE FILL VOLUMES EXCLUDE UNDERDRAIN, SLCRS, PLCS, AND OPERATIONS SOIL VOLUMES.
ISSUED AS 2021 PERMIT UPDATE
Geo-Logic ASSOCIATES
803 SW Industrial Way, Suite 211, Bend, OR 97702
geo-logic.com | 541.678.5733
VALLEY LANDFILLS, INC.
COFFIN BUTTE LANDFILL
SITE DEVELOPMENT PLAN
BENTON COUNTY, OREGON
LANDFILL ZONING
DRAWING NO.
G03
PROJECT NO.
AU20.1210

Figure 3

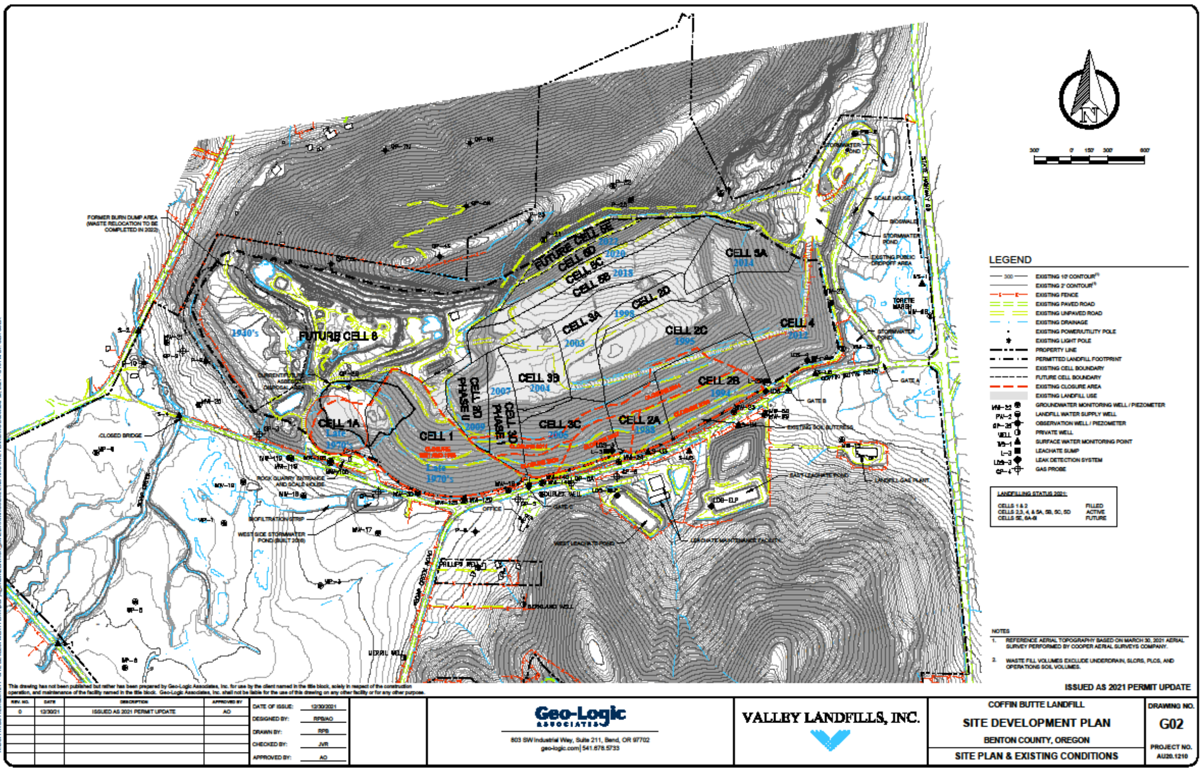

Figure 4

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Section 2: Specific Locations

Per Benton County PC-83-07-C, in 1938 a new zoning category ("LANDFILL SITE") was created for Benton County and approximately 266 acres of land owned by Valley Landfill, Inc. were rezoned with this classification. Of these 266 acres, 194 acres, all on the north side of Coffin Butte Road, were approved for waste disposal.

Figure 5 denotes the originally proposed outline for land to be rezoned as Landfill Site (LS). Note that the northernmost section of the proposed area, extending north from the ridgeline of Coffin Butte, was ultimately not rezoned as LS due to concerns from neighbors.

The overview map included in the Benton County & Valley Landfills MOU Relating to Land Use Issues (2002) document, included here as Figure 6, clarifies the zoning boundaries.

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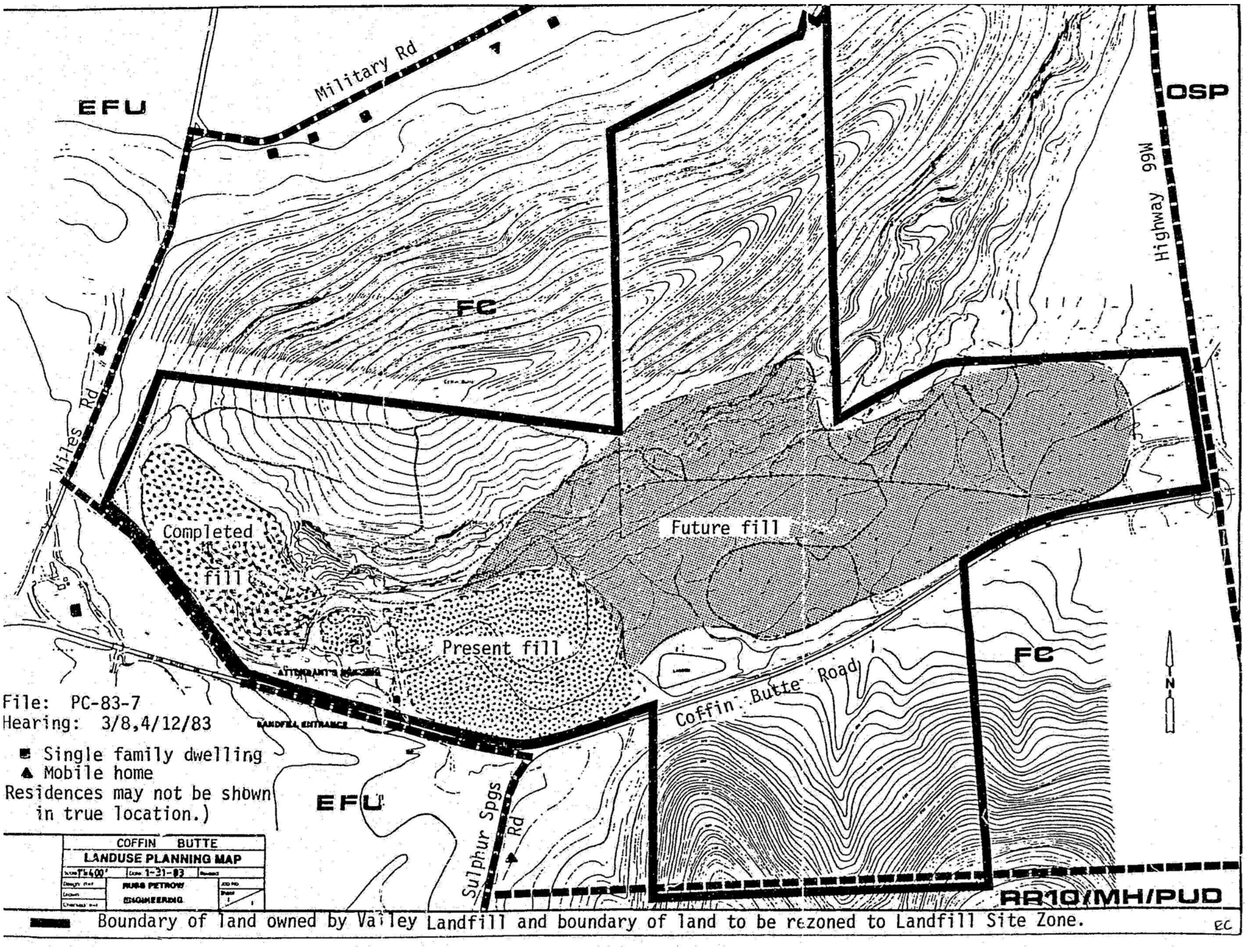
Military Rd
EFU
OSP
Highway 99W
FC
Wiles Rd
Completed fill
Future fill
Present fill
File: PC-83-7
Hearing: 3/8,4/12/83
■ Single family dwelling
▲ Mobile home
Residences may not be shown in true location.)
EFU
Sulphur Spgs Rd
Coffin Butte Road
FC
N
COFFIN BUTTE
LANDUSE PLANNING MAP
RUSS PETROW ENGINEERING
RR10/MH/PUD
Boundary of land owned by Valley Landfill and boundary of land to be rezoned to Landfill Site Zone.

Figure 5

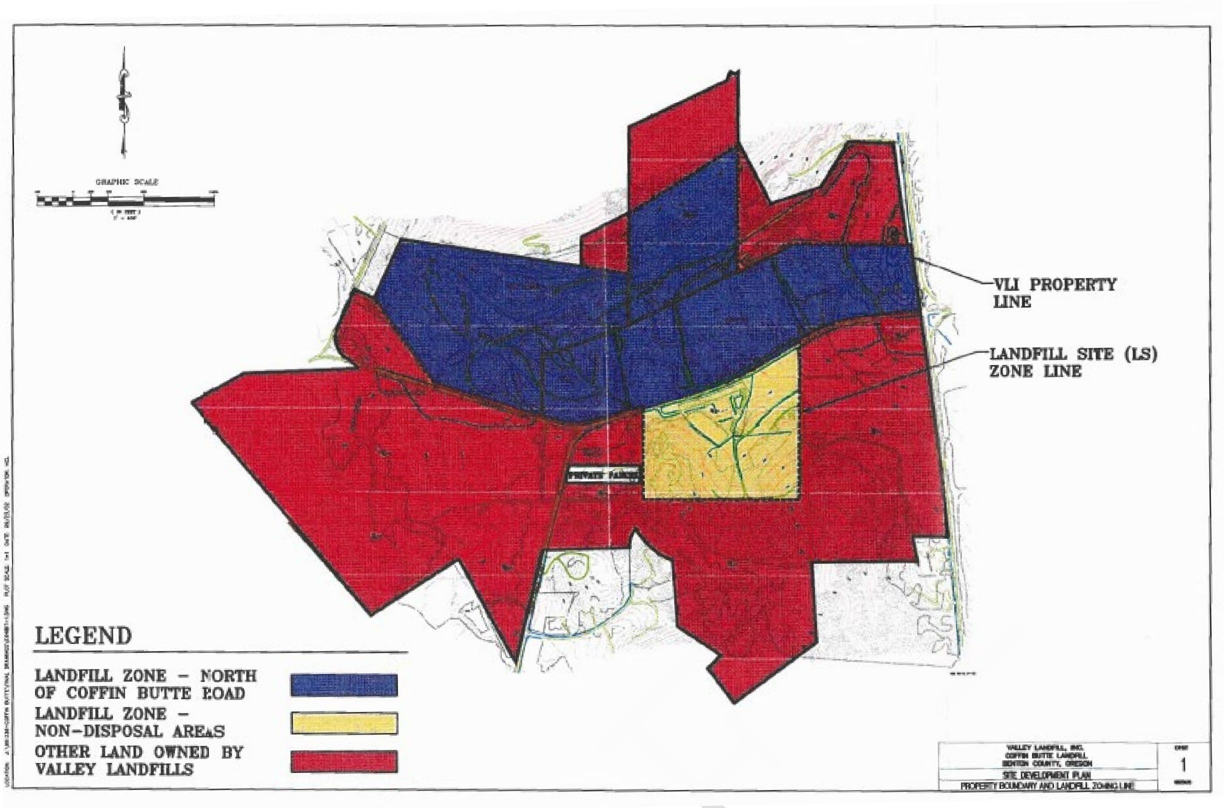

Figure 6

Other information required/useful in this section?

Section 3: Landfill Life Projections

A. Baseline: Projection to End 2022

Document calculations leading from used/available volumes quoted in 2021 Annual Report to projected End 2022 values.

Scenario 1

Tons per Year	1,000,000 Tons
Projected Remaining Airspace 12/31/22	16,008,557 CY
2022 3-year Density Avg	0.999 Tons/CY
Site Life	15.99 Years

Scenario 2

Tons per Year	1,100,000 Tons
Projected Remaining Airspace 12/31/22	16,008,557 CY
2022 3-year Density Avg	0.999 Tons/CY
Site Life	14.54 Years

Assumptions:

Tons per Year – Projected tonnage based on recent history (2019,2021) and 2020 FA tonnage cap (1.1M tons/yr). Does not reflect variables such as changes in disposal and diversion rates, natural disasters, market and regulatory changes, etc.

Projected Remaining Airspace – Airspace consumed in 2022 based on projected 2022 tonnage and 3-year Density Average. "Remaining airspace" includes approximately 2.7M cubic yards of quarry rock; how much of, and by when, this rock can be converted to airspace is currently unknown. 2022 quarry extraction freed up approximately 140,000 cubic yards.

2022 3-year Density Average – derived from 2020-22 measurements. 2022 density based on 2021 measurements.

Site Life – Time to fill the projected remaining airspace, including the airspace currently unexcavated.

< GRAPHIC EDIT: I updated the explanatory text to better communicate what we discussed about this baseline >

B. Nominal Life Projection CY 2023 to End of Life

Incorporate Ian's life projection from macnab_112222_coffin_butte_capacity.pdf.

Comments re: Scenario 1 vs. Scenario 2?

Likely somewhere between the two scenarios – 14.54-15.99 year site life*.

- Derived from Republic Services annual measurements
- Describe the underlying method for calculating these numbers
- List assumptions
- *Includes quarry, which currently has unexcavated rock
- Quarry sequencing/staging – timeline and description. May be combination of options.
- Where the landfill is currently receiving waste stands over a number of previous cells. At the time of transition to place liner in the quarry, they will be starting a new footprint, without a lot of area to fill on top of or against. Considering efficiencies of fill and stability of hill. Larger footprint needed when starting fill that is not leaning against existing fill/cell.
- Add potential factors that could change the site development plan expectations

C. Events and Factors with Potential Lifetime Impact

Consider possible disruptions impacting life (e.g. recession, wildfire, other landfill closure, regulatory (e.g. methane))?

Recession

Wildfire – ex: 2020 wildfire debris tonnage

Impacts to other disposal facilities – ex: riverbend

Contaminated soils – spills – ex: fuel tanker that spilled on highway 99

Population growth

List various known factors impacting longevity

Include footnotes that show we cannot predict every scenario

List examples using known information, not projections, but historic data for context

Not just Coffin Butte Landfill impacts, but generally all landfills

Impacts may not be immediate, but experienced over the course of years.

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Baseline Scenario
The baseline scenario described in Part A, above, graphically displays the landfill's longevity as shown in Figure 3.2, below:

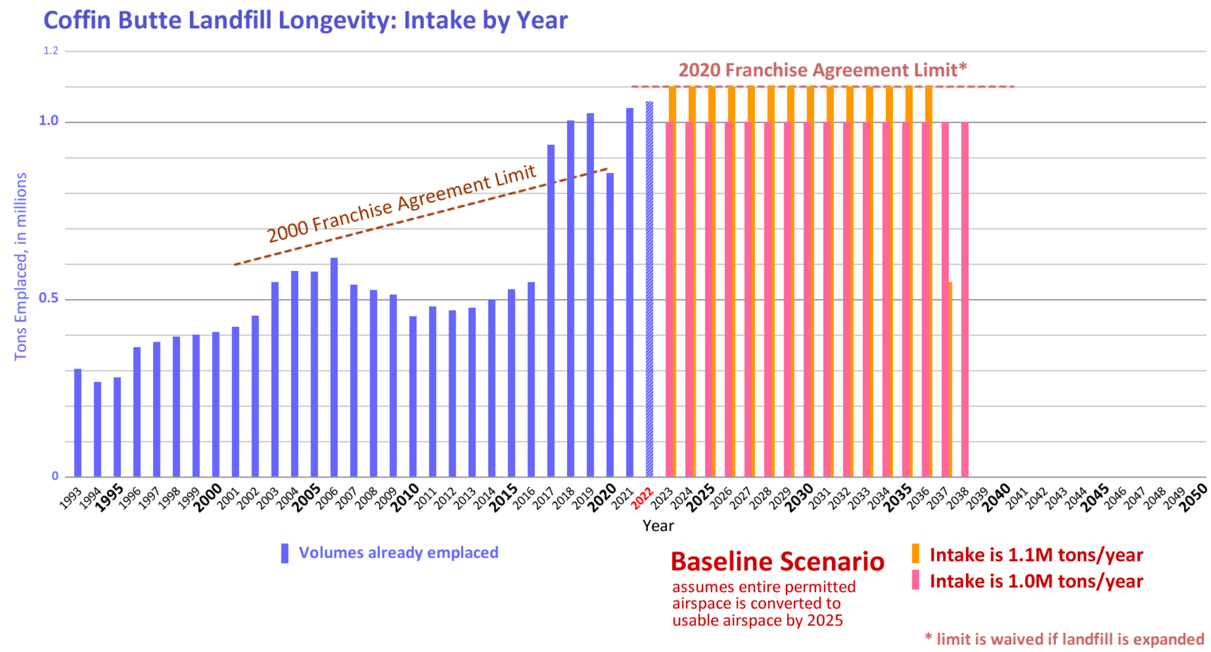


Figure 3.2

This scenario is termed a baseline because it is a simple projection that more sophisticated scenarios can be built upon. As indicated in its Assumptions, this baseline scenario is not a "default future"; it is not realistic, in that it references itself only, has no supporting data, is aspirational, and does not incorporate outside factors. It is our baseline because it models the idealized parameters (and longevity) intended for the landfill by the landfill's owner, which is: a steady annual intake of between 1M and 1.1M tons for the duration of the landfill's 14.5-16 year site life (to 2037-2039).

Scenarios built upon the Baseline: Quarry Levels
Roughly 2.7 million cubic yards of the landfill's permitted airspace is currently unavailable because it is unexcavated rock. The landfill's owner holds a surface mining permit for this rock, and franchises it to Knife River as a quarry. For the past few years Knife River has currently quarried the rock at a rate of roughly 150,000 cubic yards a year, so at a normal pace the airspace will not be fully available until the year 2040.

This poses a dilemma for the landfill's owners, because the landfill is on track to fill its current cell in 3 years, when it will look to move operations into the quarry area. The landfill and the quarry cannot safely overlap their operations in the airspace. Ideally, the quarry would pre-excavate all the rock by year-end 2024, and the landfill would then prepare the quarry site for landfilling. Alternatively, the landfill could use a new permitted area (a landfill expansion) as a "bridge" to give the quarry more time to pre-excavate, but it seems unlikely that a landfill expansion could be (a) successful and (b) legally resolved in time to be useful.

We do not currently know how much rock can be pre-excavated before landfilling operations move into the quarry airspace. We can display the possibility range graphically, in Figure 3.3.

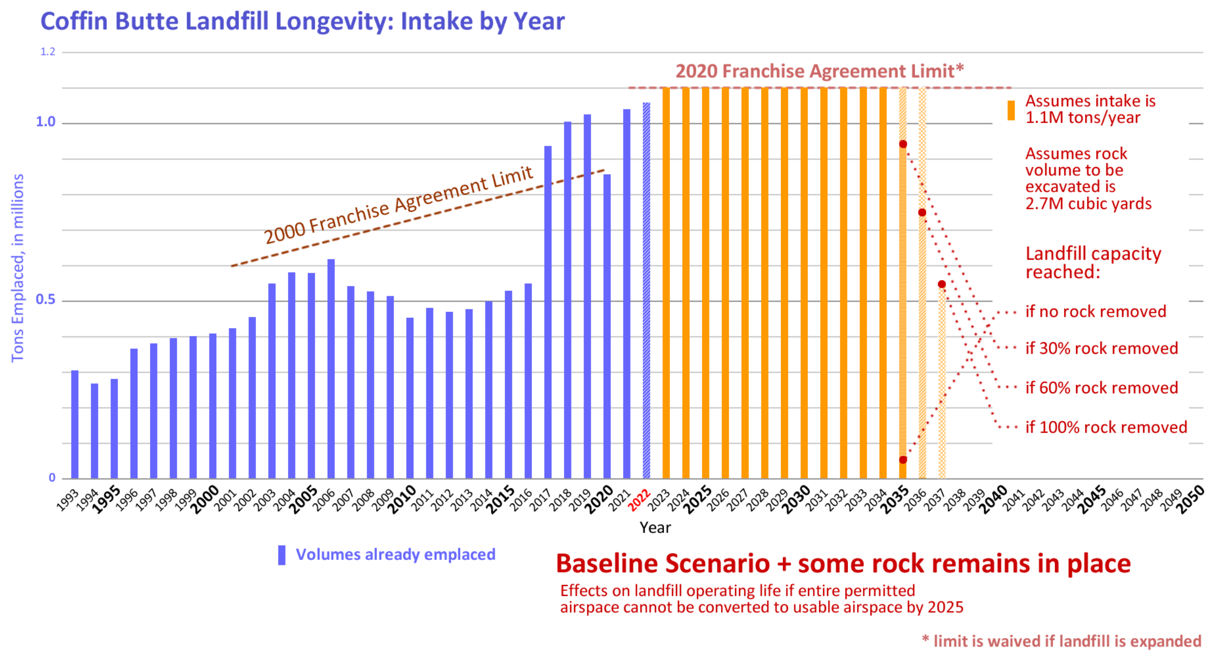


Figure 3.3

Scenarios built upon the Baseline: Water Table

A (currently unquantified) portion of the landfill's permitted airspace seems to lie below the groundwater level, and it is unclear at this time whether or not Oregon DEQ regulations will allow this theoretical airspace to be used. if not permitted, actual permitted airspace would decrease and the lifespan of the landfill would shorten, in proportion to the volume affected.

Scenarios built upon the Baseline: Expansion(s)

The baseline scenario may only be fully realized in combination with a landfill expansion – to serve as a bridge landfilling site that allows time for the quarry airspace to be pre-excavated. The landfill owner has indicated that it will apply for such an expansion, likely in the first half of 2023. Almost certainly this expansion site would be the area south of Coffin Butte Road that is already zoned as Landfill Site; it's unlikely that the expansion would involve the airspace over the road itself, as closing the road proved problematic in the 2021 expansion attempt. We can roughly estimate the size of this expansion airspace as 6M cubic yards.

This application may be followed by others, either to continue to act as bridges for quarry excavation or to take advantage of the removal of the intake cap, which happens once the first expansion is approved, according to the 2020 Franchise Agreement. These further expansions may close Coffin Butte Road or seek to rezone other areas around the landfill as Landfill Sites.

We can represent the effect this set of scenarios would have on baseline longevity, as Figure 3.4.

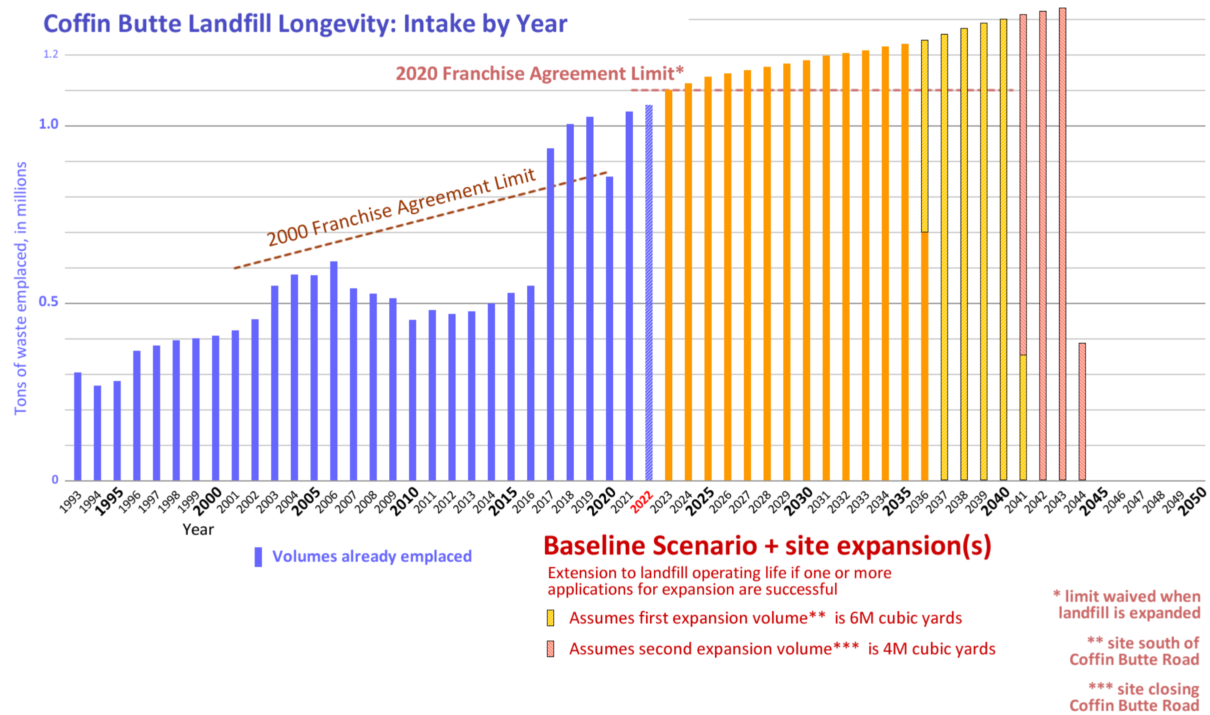
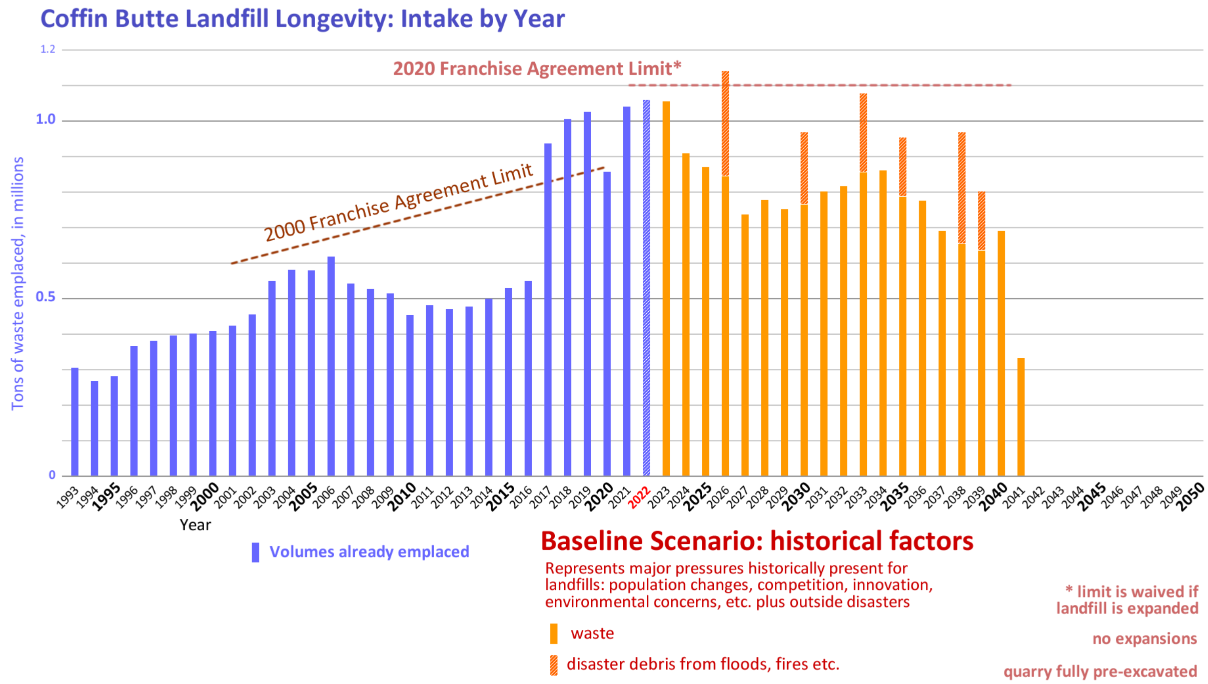


Figure 3.4

Scenarios built upon the Baseline: Historical Variance

The baseline scenario is derived primarily from the annual intake the landfill owner has achieved and would like to maintain. In reality such stability occurs rarely if ever. Historically, the annual intake of a



landfill is determined by many factors, many beyond the owner's ability to control or to counteract by expanding the wasteshed.

The following graphic (Figure 3.5) shows variance due to (a) slow but steady demand by people to reduce their "tax" of garbage disposal costs, (b) growing demand by people for less polluting alternatives to waste disposal, (c) growing population in the wasteshed, (d) competitive pressure from innovative alternatives to landfilling, (e) sudden spikes in intake due to wildfires, floods, and other climate-related disasters, and (f) pressure by the landfill owner to maintain intake via downward pricing and cost-cutting. These "human factors" are discussed more fully in Section 4.

Figure 3.5

Scenarios built upon the Baseline: Climate Crisis Legislation/Legal Action/Activism
People all over the world are growing increasingly concerned about the threat the uncontrolled release of greenhouse gases poses to the ecosystems that human societies depend upon. In the United States, this fight is focused on the release of methane, a potent greenhouse gas. Landfills are major sources of greenhouse gas emissions, especially methane. In its Methane Emissions Reduction Plan, the US government is using all available tools to identify and reduce methane emissions from all major sources. The Inflation Reduction Act of 2022 prioritized curtailing methane pollution in the oil and gas industry sector, initiating a program that catalyzes pollution detection and offers incentives for reduction and imposes penalties for continued releases of methane into the atmosphere. At the same time, environmentally engaged citizens are suing governmental agencies, and investors are suing corporations, for failing to act responsibly on the climate crisis. These signals of change are discussed in Section 4.

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Since methane is not "destroyed" nor does it become carbon neutral, the best way to mitigate landfill methane is never to create it in the first place, i.e., to divert waste, especially organic waste, from ever entering a landfill. This is a fundamental logic when curtailing landfill methane.

The preceding graphic (Figure 3.5) does not take into account these increasing pressures for action. The following graphic (Figure 3.6) shows one range of possible effects of these regulatory, legal, political and competitive pressures.

<graphic to come>

Figure 3.6

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Section 4: Human Factors Affecting Landfill Size/Capacity/Longevity

Assessing Human Factors

Although the physical parameters of Coffin Butte Landfill play a role in its longevity ("operating life"), human factors drive the actual outcome, because they determine the inflow of material that fills up the landfill's permitted volume (and shape that volume itself). Unlike the physical factors, human factors – by which we mean decisions and agreements such as business and legal obligations, legislation, enforcement, civic action and attitudes, technological advances, risk assessments and risk taking, individual and collective values and choices, and so on – have the power to shift the landfill's operating life very quickly. Estimations of the operating life of the Coffin Butte Landfill necessarily rely on assessments and assumptions about the entire system that feeds waste to the landfill, and this wider system is created by, motivated by, operated by, and continuously being changed by human factors.

When mapping possible futures, experts use different methods to assess human factors than they do for physical factors. "Scenario planning" poses *what if* questions to anticipate future possibilities. "Futures signaling" looks for events that indicate coming trends or movements. Using these futurecasting methods is important because for many people, cognitive biases limit their view of the future to be a mere extension of the present, with only incremental changes, even though their actual experience is of a world in which radical and disruptive changes are occurring at an ever-faster rate. “Imagination training” can be a useful tool to be more successful at discerning these patterns of change.

The Climate Change Imperative, and Methane

People all over the world are growing increasingly concerned about the threat the uncontrolled release of greenhouse gases poses to the ecosystems that human societies depend upon. The 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27) took place from 6 to 20 November this year, and hosted more than 100 Heads of State and Governments and over 35,000 participants who engaged in high-level meetings and key negotiations regarding climate action.[i] UN Secretary-General António Guterres said that more needs to be done to drastically reduce emissions now. “The world still needs a giant leap on climate ambition… we can and must win this battle for our lives.” He urged the world not to relent “in the fight for climate justice and climate ambition.”[ii]

In the United States, this fight is focused on the release of methane, a potent greenhouse gas. The US is one of the world’s top 10 methane emitters, and methane emissions are a major contributor to climate change, “which is why President Biden is taking critical, commonsense steps at home to reduce methane across the economy.” Last year the US announced that it was joining with more than 100 world governments to meet a Global Methane Pledge and reduce the world’s methane emissions 30% from 2020 levels by 2030. Humans produce the bulk of methane pollution, and atmospheric concentrations of methane have been trending upward for more than a decade, with 2020 seeing the biggest one-year jump on record.

Through the 2021 Methane Emissions Reduction Plan, the US government is using all available tools – “commonsense regulations, catalytic financial incentives, transparency and disclosure of actionable data, and public and private partnerships – to identify and cost-effectively reduce methane emissions from all major sources.” As part of this Plan, in a carrot-and-stick manner, the EPA has begun to both catalyze multi-pronged action against, and assess penalties for, the release of methane into the atmosphere.

Landfills are major sources of greenhouse gas emissions. Landfilling inherently creates methane as a natural byproduct of the decomposition of organic material in landfills. Landfill gas is composed of roughly 50 percent methane (the primary component of natural gas), 50 percent carbon dioxide (CO_2) and a small amount of non-methane organic compounds. Methane and carbon dioxide are odorless; “landfill smell” is from the trace non-methane organic compounds.

In the past methane pollution has been difficult to quantify. For landfills, historically the EPA has relied on theoretical calculations to estimate pollution, but these mathematical models by definition produce estimates, not exact data – useful at a national level but less so at a per-

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landfill level. In response, other organizations have engineered their own models that are more useful for assessing emissions at a particular landfill. In recent years, focus has shifted to better direct measurement technologies for more accurate and transparent emissions reporting.

Using area measurement tools deployed on satellites, aircraft, and towers, the Environmental Defense Fund has shown that landfill outputs are generally higher than EPA calculations indicate. Carbon-Mapper, a joint public-private enterprise, focuses on identifying super-emitters, because a previous flyover project across California discovered that only 1% of sites produced 50% of methane emissions, and the largest emissions were from landfills. Carbon-Mapper plans to launch two satellites in 2023, building to a suite of 20 satellites eventually; these will join other systems such as Kayrros, a French company, and MethaneSAT, a subsidiary of the EDF.

These developments all signal a changed operating environment for Coffin Butte Landfill, one in which its greenhouse gas emissions move from being unknown and unexamined to being an open number impacting waste flows, operating costs, regulatory fines, corporate investment levels, public action, and more. Coffin Butte Landfill may be a particular target for negative effects, because its wet environment converts waste to methane quickly. This section details several Scenarios which explore these impacts upon the landfill's anticipated operating life.

It's important to note here that landfill methane poses a lesser-of-evils situation. The best-case environmental outcome for methane, once it is generated from municipal solid waste, is for it to oxidize into carbon dioxide, i.e., for it to transition from a quick-acting high-impact greenhouse gas into a slower-acting, durable greenhouse gas. Methane is not "destroyed" nor does it become carbon neutral. Therefore, the best way to mitigate landfill methane is never to create it in the first place, i.e., to divert waste, especially organic waste, from ever entering a landfill. This is a fundamental logic at work with landfill methane now and into the future.

Scenarios

A. Climate Crisis Legislation

Scenario: the methane-corrective measures imposed on the oil/gas industry are extended into the landfill industry, focusing on incentives to prevent methane from being emitted but including penalties for methane pollution. This extension happens in the year 2024.

In this scenario, as they are doing in the oil/gas industry, federal and state environmental agencies offer billions of dollars in incentives tailored to catalyze efforts that can curtail landfill methane.

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In this scenario, federal and state environmental agencies announce and implement financial penalties (fines) for methane release to the atmosphere. As is currently happening in the oil/gas industry, these penalties are eased in over a four-year period, and cap at a rate around $1550 per metric ton in 2022 dollars.

In general, the effect of this carrot + stick scenario on Coffin Butte Landfill's operating life would be to lengthen it. The incentives would attract recyclers and other entities to target the high-organic sector of the landfill's intake (about a quarter of total intake mass) for diversion away from the landfill, and the penalties would bring the landfill operator into alignment with this diversion (and reduction of profit). This would be a sea change in the wasteflow, creating knock-on opportunities to create circular economies for other types of waste, motivated by environmental concerns, economic efficiencies, and other reasons.

It's also possible that this scenario would shorten the operating life of Coffin Butte Landfill, even precipitously, if the prospective penalties for incoming waste (plus the penalties for methane emissions from waste already emplaced) cut unacceptably into the profit schema of the landfill owner. The likelihood of this eventuality depends upon the actual methane output of the landfill, which is currently undocumented.

The signal for this scenario is strong, because it is based upon the stated goals of the US government, its commitments to climate action to the world, and goals and provisions already in place with the US 2021 Methane Emissions Reduction Plan.

Another legislative scenario to mention briefly, related to the climate crisis: efforts to limit atmospheric carbon widen to non-methane sources in the US, in the form of a carbon tax and/or subsidies for rail electrification. This scenario would disrupt the current operations in the Coffin Butte wasteshed, by establishing new incentives to transport waste by rail rather than truck. This scenario is likely to extend the operating life of Coffin Butte Landfill, which has no rail connection and depends on trucking for its inflow. If entities can transport waste more economically by rail to cleaner landfills or to regional waste reclamation centers, that would cut inflow to Coffin Butte Landfill.

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B. Climate Crisis Legal and Shareholder Action

Scenario: Environmentally engaged citizens sue governmental agencies (and investors sue corporations) for failing to act on the climate crisis. These lawsuits compel action to reduce emissions of greenhouse gases, which in turn boost efforts to divert material, especially food and other high organic waste, from being landfilled at Coffin Butte Landfill. In this scenario, these lawsuits have the potential to occur across the wasteshed.

Signals for this scenario set exist in plenty. Groups of environmentally engaged citizens are already pursuing lawsuits against states and nations; such cases appear regularly in the news as current ones wind their way through the courts and new ones are filed. Climate activism is already widespread in Oregon and the landfill's wasteshed includes areas disposed politically toward this kind of legal action. Benton County is more likely than most to be targeted for this kind of lawsuit, as its population generally prioritizes environmental concerns and the County has not shown concern over greenhouse gas emissions in its administration of Coffin Butte Landfill.

"I started looking at the world through a new lens recently — when my older daughter gave me the incredible news that I'll become a grandfather next year… I can sum up the solution to climate change: We need to eliminate global emissions of greenhouse gases by 2050… We need to revolutionize the entire physical economy… If we don't get to net-zero emissions, our grandchildren will grow up in a world that is dramatically worse off." The grandfather-to-be is Bill Gates, a major shareholder in Republic Services' stock.

This scenario would further extend the operating life of the landfill if methane studies show that Coffin Butte Landfill is a worse polluter than alternative landfills in drier climates (if Coffin Butte Landfill converts waste to methane more quickly, for example). The legal action would then not only divert high-organic material out of the wastestream, but divert unsorted waste away from Coffin Butte Landfill to less-polluting alternatives.

C. Climate Crisis Environmental Activism

Scenario: Environmental activists accelerate their efforts to increase accountability for, and limit waste intake at, Coffin Butte Landfill. These efforts consist mostly of expansion to the current level of civic engagement but also branch out as protests and other direct action when civic engagement cannot produce the depth and velocity of change required for environmental protection.

This scenario is similar to, and operates in tandem with, the "legal action" scenario, and has a similar effect of reducing intake at the landfill. Activism happens more quickly however, so the primary impact of this scenario is as an across-the-board accelerant and forcer for all the environmentally motivated changes being discussed in this section.

Signals for environmental activism's impact on the operating life of Coffin Butte Landfill are very strong. Environmental activism has already caused the single most impactful event on the operating life of Coffin Butte Landfill in its history: activists stopped the expansion of the Riverbend Landfill in Yamhill County, which effectively doubled trash intake at Coffin Butte Landfill to its current high level. Local activism is why the County has assembled its Workgroup studying the future of solid waste management in Benton County, and local activists feature prominently in the work done by the Workgroup so far.

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D. Climate Crisis Effects Upon Landfill Operating Life

Scenarios: effects of the climate crisis itself circle back to affect the operating life of Coffin Butte Landfill, by increasing the incidence of wildfires, floods, droughts, and other disruptions to the landfill's extensive infrastructure; by causing rapid and novel shifts in population migrations and attitudes; by posing threats to the landfill's operational status itself.

Signals for this set of scenarios are strong. Worldwide, the number and severity of climate events and disasters is growing, made more extreme by climate-crisis effects. Locally, in 2020 the Beachie Creek–Lionshead wildfire generated about a third of a million tons of debris for Coffin Butte Landfill. The region continues to slide into multi-year drought, which extends the fire season in an area already at risk with high forest fuel loads. The Willamette Valley now has a regular "smoke season." Rain events are growing in severity, increasing chances for flood events in the landfill's wasteshed and on the landfill itself. As a creator of flammable methane, the landfill has clear potential for a major fire event; it has caught fire in the past, which on one occasion called for a large fire response and took over 24 hours to bring under control.

Despite these trends, the Pacific Northwest is seen as a haven for those elsewhere who have been even more severely impacted by heat, fire, flood and other disasters.

In the main, climate crisis events are likely to shorten the landfill's operating life. Fires and flooding have the potential to generate debris flows that will consume capacity, as would a population boost from climate refugees relocating into the wasteshed.

The most extreme scenarios shorten the landfill's operating life precipitously. The landfill itself could have a flooding event, where leachate cannot be pumped out fast enough or overflows its collection ponds for example, with effects unknown upon the landfill's ability to continue operations. Wildfire is a clear existential threat, as landfills are full of both incendiary methane and flammable material; landfill fires can burn deep, are difficult to fight and have been known to burn for years and take over a hundred million dollars to extinguish.

These events concatenate: a storm event, for example, might knock out power to the landfill for an extended period, which then leads to a flood event as pumps cannot operate. An earthquake could cause both a power outage, which collapses the landfill's ability to operate its methane extraction system, and multiple wildfires, which threaten to ignite the uncontrolled methane. In such scenarios, the landfill is not a direct threat to human life and thus not a priority for firefighters or other emergency action, so any incident can snowball.

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E. Longevity: Post-Operational Costs

Climate legislation, activism, crisis events, and so on are all increasing the burden of monitoring and maintaining public safety for the decades required after the landfill ceases operations. It's estimated that the landfill will continue to produce significant amounts of methane for 20 years after it closes, for example. If that methane is incurring penalties, who will be paying them? If trees need to be prevented from growing on the landfill cover, who will be performing that maintenance? And so on, through a growing list of like questions.

Scenario: As a clearer picture of the landfill's post-operational burden emerges, it sparks action to cut the landfill's waste intake. This effort may be initiated by the County, in an effort to both reduce the landfill's pollution impacts and to put off the day when responsibility for the landfill is transferred to the County; it may be initiated by citizens, in an effort to both reduce the pollution impacts and to delay transition to another waste management scheme; it may be initiated by the landfill owner, in an effort to delay incurring expensive post-operation environmental mitigations, and/or to keep alive the legal option to file for expansion.

Signals for this scenario include the current litigation at Riverbend Landfill in Yamhill County, where the landfill owner is trying to avoid closing the landfill by taking in a minimal amount of trash per year, and county citizens are suing to force the landfill to close.

F. Unforeseen Novel Effects

The scenarios listed above have signals that are easy to discern, and they manifest in more or less familiar ways. The level of change at work here, however, signals the strong possibility for novel and unforeseen effects, especially concatenating ones. In the same way that COVID manifested itself in a myriad of ways that were difficult to anticipate, the climate crisis is causing changes with ripple effects that have yet to become apparent.

These effects inject (more) uncertainty into the agreements and infrastructure of the landfill's wasteshed, which in turn steers the entities in the wasteshed toward reducing their waste flows and increasing the resilience of their waste management by seeking other options. The unforeseen effects of climate change are likely to increase the landfill's operating life.

G. Contractual Obligations

From day to day the wasteflow to Coffin Butte Landfill is governed by business contracts that Republic Services holds with various entities; the landfill's wasteshed is defined and redefined by these contracts. Republic Services will not provide detail about these contracts, citing their

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proprietary nature, so the wasteflow's net effect upon the operating life of the landfill is undocumented.

Imagination Training

When thinking about the future, it's common for people to manifest a cognitive bias toward the status quo, to think the future is settled as an extension of the present. This bias can manifest itself even when change is clearly underway. To counteract this bias, it's useful to require the arguments FOR the continuation of the status quo (rather than just accepting it as being unquestioningly able to continue).

To refute the idea that measures to prevent methane leaks will be extended from the oil/gas industry to the landfill industry, for example, would require a line of reasoning as to why those measures wouldn't be extended into the landfill industry (which is known to leak methane).

Another example: minimizing the role of environmental activism (as a human factor in the landfill's operating life) would require a line of reasoning as to why such activism will cease impacting the state's landfilling ecosystem or will not continue to grow at its current pace.

Imagination training is also useful in exposing areas where data still holds sway, even though it is now known to be limited or obsolete, i.e., where an old idea perseveres purely through momentum or inertia. An example would be the methane emissions level at Coffin Butte Landfill: to persist in relying on an obsolete EPA estimate would require a line of reasoning as to why that estimate should hold sway over modern direct measurements.

Determining Landfill Longevity

< summary of human factors to come >

< graphic to come >

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Appendix A: Intake Volume Data

Coffin Butte annual intake volume, derived from 1993-2021 Coffin Butte Annual Report (CBAR) documents. CY 2000 is highlighted to indicate this value was derived from the 2001 report because the 2000 report document is unavailable.

Year	CBAR Volume (Tons)
1993	310,648
1994	268,472
1995	287,932
1996	369,835
1997	378,919
1998	395,751
1999	401,408
2000	413,493

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2001	425,723
2002	453,261
2003	550,506
2004	586,076
2005	580,275
2006	618,340
2007	546,996
2008	528,396
2009	519,058
2010	458,590
2011	482,951
2012	473,550
2013	479,160
2014	499,687
2015	530,971
2016	552,979
2017	941,430
2018	1,010,879
2019	1,034,934
2020	863,210
2021	1,046,067

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Appendix B: Capacity Data

Year	Annual CBR Tons Scaled Intake	CBR Density Aerials	CBR Annual Airspace Used (CY) Landfilled	CBR Remaining Airspace (CY)	Geo Logic 2021 Plan Consumed Airspace (YD)	Geo Logic 2021 Plan Remaining Airspace (YD)
2010	458,590	0.892 tons/cy	514,111	39,594,002		
2011	482,951	0.1.0375 tons/cy	465,495	24,807,718		
2012	473,440	0.83 tons/cy	572,825	23,741,813		
2013	479,160	0.92 tons/cy	523,100	24,458,567		
2014	499,687	0.92 tons/cy	545,510	24,458,363		
2015	530,971	0.89 tons/cy	595,593	23,839,138		
2016	552,979	0.93 tons/cy	592,689	22,453,729		
2017	941,430	0.97 tons/cy	969,048	21.727,371		
2018	1,010,879	0.99 tons/cy	1,021,090	20,427,503		
2019	1,034.934	0.80 tons/cy	1,293.668	18,352,257		
2020	863,210	1.0 tons/cy	863,210	17,621,208		
2021	1,046,067	0.98 tons/cy	1,046,415	17,249,778	1,072,037	4,834,330
2022					1,057,700	3,776,631

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2023					1,057,700	2,718,931
2024					1,057,700	1,661,232
2025					1,057,700	603,532
2026					1,057,700	1,028,093
2027					1,057,700	999,823
2028					1,057,700	1,685,254
2029					1,057,700	626,554
2030					1,057,700	1,428,675
2031					1,057,700	370,975
2032					1,057,700	391,696
2032					1,057,700	1,020,066
2034					1,057,700	1,977,627
2035					1,057,700	919,927
2036					1,057,700	1,157,678
2037					1,057,700	99,978
2038					664,409	664,409

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Each year Republic Services produces an annual report for Coffin Butte Landfill & Pacific Region Compost (CBR).

In particular, during year of 2021 the landfill accepted 1,046,067 tons of solid waste. Based on historical aerial fly-over data, the average effective density of the in-place waste at the Coffin Butte Landfill is 0.98 tons/cy (1,961 lbs. /cy – 2021 Operational Density). Therefore, an estimated 1,067,415 cubic yards of airspace was used for the year. A total of 21,389,767 cubic yards has been consumed as of December 31, 2021. The remaining capacity for the entire permitted landfill footprint as of the end of 2021 was approximately 17,249,778 cubic yards. This information is updated annually with aerial flyovers. Using 0.80 tons/cy, the remaining available landfill space expressed in tons is about 13,799,822 tons. Using an average disposal rate of approximately 750,000 tons per year, there are about 18.40 years of landfill space available. If we use our 3-year density average of 0.93 tons/cy, the site life extends to 21.38 years.

This illustrates the importance of density on landfill site life.

As the density is lowered per ton of solid waste, then more headspace is consumed in the landfill thereby lowering landfill space available.

Simply put one ton of feathers has a higher capacity of volume with less density than one ton of bricks.

In the early years, the density of reporting by aerial survey technologies was not yet developed.

Year	Annual CBR (Tons) scaled Intake	CBR Density Aerials	CBR Annual Airspace Used (CY) Volume
1993	310,648		
1994	268,472		
1995	287,932		
1996	369,835		
1997	378,919 Averaged		
1998	395,751		
1999	403,697		
2000			
2001	426,000	0.9 tons/cy	473,000
2002	457,000	0.98 tons/cy	461,000
2003	550,360	0.98 tons/cy	561,592
2004	589,147	0.80 tons/cy	736,434
2005	580,275	0.80 tons/cy	725,334
2006	624,875	0.80 tons/cy	781,094
2007	546,996	0.80 tons/cy	683,746
2008	528,395	0.80 tons/cy	660,494
2009	519,058	0.80 tons/cy	648,823

[i] Endnotes to come.

[ii] Endnotes to come…

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