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ENVIRONMENTAL STANDARDS DIVISION

2021 BIOSOLIDS DEWATERING, MONITORING, DISPOSAL, AND MASTER PLAN UPDATE

ENVIRONMENT ACT LICENCE #1089E RR

January 2022

Water and Waste
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Manitoba Conservation and Climate
Environmental Compliance and Enforcement Branch
1007 Century Street
Winnipeg, MB R3H 04W

January 31, 2022

Attention: Ms. Kristal Harman, Director

RE: 2021 ANNUAL COMPLIANCE REPORT - ENVIRONMENT ACT LICENCE 1089E RR

Please find enclosed the City of Winnipeg's 2021 Biosolids Dewatering, Monitoring, Disposal and Master Plan Update Report in accordance with Environment Act Licence No. 1089E RR.

Included in this report are details of the:
a) 2021 biosolids distribution and monitoring programs
b) proposed 2022 biosolids distribution and monitoring programs
c) activities undertaken as part of the Biosolids Master Plan

Please let me know of any concerns or questions respecting this submission. I may be reached by telephone at 204-986-8359 or by e-mail at rgrosselle@winnipeg.ca.

Yours sincerely,

Original signed by R. Grosselle:
(Signed original available upon request)

R. Grosselle
Manager of Environmental Standards

Enclosures
cc: M.L. Geer, CPA, CA (email)
C. Wiebe, P. Eng. (email)
C. Carroll, P. Eng. (email)
M. Gordichuk, CCLP (email)

ENVIRONMENTAL STANDARDS DIVISION
2230 Main Street, Winnipeg, Manitoba R2V 4T8
DIVISION DES NORMES ENVIRONNEMENTALES
2230, rue Main, Winnipeg (Manitoba) R2V 4T8

T. | Tél. : 204-986-4684
F. | Fax : 204-339-2147
winnipeg.ca/waterandwaste

2021 BIOSOLIDS DEWATERING, MONITORING, DISPOSAL, AND MASTER PLAN UPDATE

HEATHER DEMCHENKO, B. SC.
COMPLIANCE REPORTING TECHNICIAN

NANCY CRAWFORD, B. SC.
COMPLIANCE REPORTING BRANCH HEAD

RENÉE GROSSELLE, B. SC.
MANAGER OF ENVIRONMENTAL STANDARDS DIVISION

JANUARY 2022

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2021 Biosolids Dewatering, Monitoring, Disposal, and Master Plan Update

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1.0 INTRODUCTION

Environment Act Licence (EAL) #1089E RR, issued on June 14, 2000, requires that the City of Winnipeg monitor its biosolids dewatering and disposal operations and submit a report to the regulating authority and various municipalities on or before the 31st of January of each year.

Biosolids are an end product of sewage treatment, created when solids and sludge that are separated from wastewater are digested and dewatered. They are rich in nutrients and also contain metals and trace amounts of minerals.

Historically, the City of Winnipeg's biosolids were spread on agricultural fields to act as a fertilizer under a program known as WinGRO. In 2011, the allowable biosolids application rates were reduced. The existing WinGRO equipment could not operate at the reduced rates, and the program was discontinued as a result. From 2011 to 2014, all biosolids produced at the City of Winnipeg's North End Pollution Control Centre (NEWPCC) were disposed of at the Brady Road Resource Management Facility (BRRMF).

In 2014, the City of Winnipeg developed a Biosolids Master Plan[1] (BMP), a 30-year plan for maximizing the recovery and beneficial reuse of the nutrients contained in biosolids.

This report summarizes the results of the City's 2021 Biosolids Dewatering, Monitoring, and Disposal Program, and provides an update of activities taken in 2021 under the BMP.

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2230 Main Street, Winnipeg, Manitoba R2V 4T8
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winnipeg.ca/waterandwaste

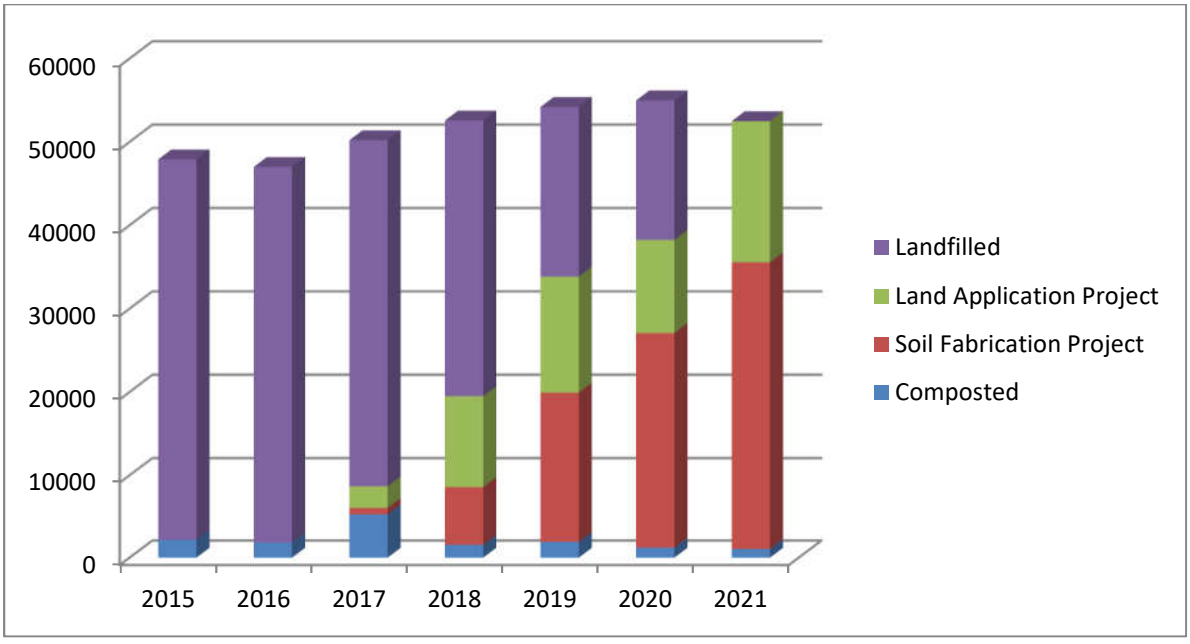
2.0 BIOSOLIDS COMPOSITION AND DISTRIBUTION

From January 1, 2021 to December 31, 2021 the City produced 52,493 wet tonnes of anaerobically digested, mechanically-dewatered biosolids at the NEWPCC; the total solids in the biosolids averaged 23.6 ± 2.8% (n = 257). The dewatering equipment achieved a total solids content of at least 20 percent by weight in the biosolids, except on January 5, July 28, and December 9, when a total solids content of 19.0%, 19.9%, and 19.6% were achieved respectively.

Of the 52,493 wet tonnes of biosolids produced in 2021, approximately 16,932 wet tonnes were applied to agricultural land, 25,702 wet tonnes were used for soil fabrication at the Summit Landfill, 8,793 wet tonnes were used for soil fabrication at the BRRMF, and 1,066 wet tonnes were composted at the BRRMF; no biosolids were landfilled at the BRRMF in 2021. The temporary storage facility in the RM of West St. Paul was not used to provide interim storage for mechanically-dewatered biosolids in 2021 and will not be used for biosolids storage in 2022.

The 2015-2021 Biosolids Distributions are shown in Figure 1, Table 1 contains analytical results for 2021 biosolids samples, and Appendix I contains the Monthly Hauling Summaries for 2021.

FIGURE 1: 2015-2021 BIOSOLIDS DISTRIBUTION



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F. | Fax: 204-339-2147
winnipeg.ca/waterandwaste

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TABLE 1

2021 Biosolids Quality

Sample Number	Date Sampled *	Total Cd (mg/Kg-Cd)	Total Cr (mg/Kg-Cr)	Total Cu (mg/Kg-Cu)	Total Ni (mg/Kg-Ni)	Total Pb (mg/Kg-Pb)	Total Zn (mg/Kg-Zn)	Total P (mg/Kg-P)	NH3-N (mg/Kg-N)	TKN (mg/Kg-N)	pH (units)	Specific Conductance (uS/cm)	Moisture (%)
1	4-Jan-21	7.9	67	711	37.5	32.4	1,104	25,430	13,020	48,000	6.03	11,600	79.8
2	18-Jan-21	6.9	90	678	42.8	32.8	1,082	25,520	12,510	49,800	6.08	12,600	79.1
3	1-Feb-21	5.4	90	773	43.7	39.1	1,117	26,130	12,140	48,900	5.98	10,800	78.8
4	16-Feb-21	4.5	102	793	48.5	43.8	1,497	31,250	9,149	37,100	6.01	10,100	76.5
5	1-Mar-21	2.3	63	483	30.3	33.7	857	19,570	9,049	42,700	5.96	9,100	74.0
6	15-Mar-21	1.9	60	482	29.0	35.2	813	18,660	8,232	38,300	5.75	10,200	73.3
7	29-Mar-21	1.9	61	487	30.4	37.0	772	18,670	6,906	38,100	6.11	10,400	73.4
8	12-Apr-21	1.8	64	457	33.3	41.6	1,065	19,300	7,914	31,500	5.78	8,500	70.4
9	26-Apr-21	1.4	70	415	29.6	36.4	1,828	19,000	6,025	38,100	5.86	10,600	58.8
10	10-May-21	1.8	75	465	30.1	33.6	1,639	20,520	9,030	43,700	5.95	10,800	75.4
11	25-May-21	1.8	73	443	30.5	50.5	1,166	17,160	6,623	38,000	5.93	9,170	73.9
12	7-Jun-21	1.6	79	461	30.3	52.5	969	17,040	8,989	36,700	5.96	12,100	73.7
13	21-Jun-21	4.7	91	572	30.2	52.5	1,073	19,770	9,770	37,200	5.99	11,100	75.2
14	5-Jul-21	5.2	76	571	34.0	56.3	931	19,560	9,344	43,500	6.04	10,600	77.9
15	19-Jul-21	4.0	87	597	33.8	38.8	1,036	19,110	9,709	47,000	5.98	12,000	77.7
16	3-Aug-21	3.4	85	621	35.9	44.6	1,176	20,060	8,592	44,400	6.05	13,500	78.1
17	16-Aug-21	2.6	85	582	34.7	70.6	1,093	16,340	10,740	37,300	5.87	11,200	76.4
18	30-Aug-21	2.3	92	605	40.8	77.3	1,000	17,150	10,790	41,300	5.81	12,700	75.5
19	13-Sep-21	2.3	196	630	33.0	67.4	905	17,220	10,480	49,700	6.30	11,800	77.1
20	27-Sep-21	2.0	498	676	29.8	53.2	2,052	18,760	11,660	29,500	5.98	12,600	79.0
21	12-Oct-21	1.7	358	659	30.7	60.0	2,857	18,670	9,789	44,500	5.97	12,000	77.8
22	25-Oct-21	1.7	219	680	30.3	49.5	1,960	18,790	8,227	38,400	6.42	11,300	77.7
23	8-Nov-21	2.2	152	674	28.6	44.7	1,366	18,260	11,320	40,800	5.98	14,600	77.1
24	22-Nov-21	2.7	120	666	31.1	39.1	1,940	19,380	11,700	49,500	6.14	16,400	78.0
25	6-Dec-21	5.5	128	659	32.8	33.7	1,980	22,460	10,040	41,300	6.06	14,100	78.4
26	20-Dec-21	4.2	122	619	29.3	28.7	1,548	25,000	8,505	43,000	5.91	14,400	77.9
	Average:	3.2	123	595	33.5	45.6	1,339	20,338	9,625	41,473	6.00	11,703	75.8
	Maximum:	7.9	498	793	48.5	77.3	2,857	31,250	13,020	49,800	6.42	16,400	79.8
	Minimum:	1.4	60	415	28.6	28.7	772	16,340	6,025	29,500	5.75	8,500	58.8

*** Indicates starting date for biweekly composite samples**

3.0 BENEFICIAL REUSE OF BIOSOLIDS

(A) BIOSOLIDS LAND APPLICATION

Land application of biosolids is a considered beneficial reuse because it provides nutrients for agricultural crop production. The City has been conducting In-Field Storage and Land Application programs since 2018. An Environment Act License (EAL) application is currently under review by the Manitoba Conservation and Climate (MCC), Environmental Approvals Branch (EAB), in the interim the City submits a Notice of Alteration (NOA) for EAL No. 1089E RR for its program annually.

In April 2021, the EAB approved City's 2021 NOA for the temporary in-field storage and land application of up to 20,000 wet tonnes of biosolids onto agricultural land within the RM of Macdonald. From June to October, a total of 16,051 wet tonnes of biosolids were stockpiled at two in-field storage sites which had straw beds and berms for leachate management. Straw was applied over the biosolids each evening after deliveries to cap the biosolids and ensure odour and vector control. Following harvest, soil samples were analyzed to determine the application rate of 46 wet tonnes per hectare. The stockpiled biosolids were land applied from September 13-15 and October 22-25 and 881 wet tonnes of biosolids were hauled and direct land applied between September 15-23. In 2021 a total of 16,932 wet tonnes of biosolids materials were land applied.

Odours at the stockpile site and at pre-determined distances from the stockpile site were classified as annoying to very annoying by an odour assessment team. Odour assessments were also conducted at select locations surrounding the fields during application, with the highest odour level classified as very annoying. The RM of Macdonald Reeve and Council did not receive any complaints about odours during the 2021 program and the City did not receive any odour concerns from the public through the project phone number or email address.

In 2021, soil samples were collected from fields that received biosolids in 2018, 2019 and 2020; the post-harvest residual nitrate-nitrogen results were greater than anticipated, likely due to the drought conditions experienced through the 2021 growing season and resulting crop failure. The phosphorus results were below the applicable Nutrient Management Guidelines.

A detailed description of the project, including analytical results, is found in The City of Winnipeg Biosolids Land Application Program Annual Summary Report 2021, which will be submitted to MCC in March/April 2022.

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2230 Main Street, Winnipeg, Manitoba R2V 4T8
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T. | Tél. : 204-986-4684
F. | Fax: 204-339-2147
winnipeg.ca/waterandwaste

(B) SOIL FABRICATION

The use of biosolids as an ingredient in the fabrication of soil for use in cap systems at landfill sites is considered a beneficial reuse because nutrients are recovered by vegetation that grows in the fabricated soil. In February 2017, Manitoba Sustainable Development (MSD), now Manitoba Conservation and Climate (MCC) approved a Notice of Alteration (NOA) to Environment Act Licence (EAL) No. 3081R for a pilot Soil Fabrication Project at the Brady Road Resource Management Facility (BRRMF) and in the fall of 2020, MCC approved an extension to the 2018-2020 pilot Soil Fabrication Project at the Summit Landfill.

In 2021, approximately 34,495 wet tonnes of biosolids were mixed with wood chips and either street sweepings or clay to produce fabricated soil, which was used in the cap systems at Summit Landfill and BRRMF.

At the Summit Landfill, odours were noted locally during receiving operations, but they were reduced after mixing the biosolids with woodchips and street sweepings. No odours were detected offsite during the biosolids receiving or soil spreading operations and no odour complaints were received through 311 or other public sources. At the BRRMF, no odour complaints were attributed specifically to biosolids. There were no dust, noise, vector, or nuisance concerns during operations at the Summit Landfill or the BRRMF.

In 2022, the target is to use approximately 36, 000 wet tonnes of biosolids in soil fabrication projects. The projects will include spreading and seeding operations and environmental monitoring including surface water, soil, and vegetation monitoring and analysis.

A detailed description and findings of the 2021 project at the Summit Landfill will be included in the Summit Landfill Soil Fabrication Pilot Project Year Four Annual Report, which will be submitted to MCC in March 2022. A detailed description and findings of the 2021 project at the BRRMF will be included in the 2021 BRRMF Annual Report, which will be submitted to MCC in April 2022.

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(C) COMPOST

The composting of biosolids is considered a beneficial reuse because nutrients are retained in the final product. The City of Winnipeg conducted a pilot biosolids composting program from 2015 to 2018, which produced a low odour, nutrient rich compost with low metals content. The City of Winnipeg Biosolids Compost Pilot Report[2] provides a detailed description of the project. An NOA to the BRRMF EAL 3081R allows for ongoing operational biosolids composting.

In 2021, 1,066 wet tonnes of biosolids were diverted to the compost facility. Bio-filters on the biosolids compost facility are used to control odours; none of the odour complaints reported for the BRRMF in 2021 were attributed specifically to biosolids.

In 2022, biosolids composting will continue on an as-needed basis to meet final cover needs at the BRRMF.

(D) LANDFILL DISPOSAL

Landfill disposal of biosolids is not considered a beneficial reuse because valuable nutrients are not recovered. Of the 52,493 wet tonnes of biosolids produced at the NEWPCC in 2021, none were disposed at the BRRMF.

In 2022, biosolids that are not composted, land applied, or used in soil fabrication projects will be disposed of at the BRRMF.

4.0 ADDITIONAL ACTIVITIES UNDER THE BIOSOLIDS MASTER PLAN

An application for Provincial and Federal funding for a new digestion facility with thermal hydrolysis pre-treatment at the NEWPCC, is under review. This facility has been ranked as the City of Winnipeg's #1 infrastructure project. Updates pertaining to design and construction of the new digestion facility will be reported to MCC in the bi-annual NEWPCC Master Plan Reports.

5.0 REFERENCES

1. COW/Veolia. September 2014. City of Winnipeg Biosolids Master Plan

2. COW. October 2018. City of Winnipeg Biosolids Compost Pilot Report

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winnipeg.ca/waterandwaste

APPENDIX I
MONTHLY HAULING SUMMARIES

2021 Biosolids Management Program

January			2021											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads for Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1														
2	120.13	20.71	24.88	0	1	0	4	0	5	0.00	24.06	0.00	96.07	0.00
3														
4	264.59	20.71	54.80	0	11	0	0	0	11	0.00	264.59	0.00	0.00	0.00
5	264.17	19.00	50.19	0	11	0	0	0	11	0.00	264.17	0.00	0.00	0.00
6	238.44	20.71	49.38	0	10	0	0	0	10	0.00	238.44	0.00	0.00	0.00
7	216.30	20.25	43.80	0	9	0	0	0	9	0.00	216.30	0.00	0.00	0.00
8	144.02	20.40	29.38	0	6	0	0	0	6	0.00	144.02	0.00	0.00	0.00
9														
10														
11	216.97	20.95	45.46	0	9	0	0	0	9	0.00	216.97	0.00	0.00	0.00
12	240.98	20.71	49.91	0	10	0	0	0	10	0.00	240.98	0.00	0.00	0.00
13	240.44	20.71	49.80	0	10	0	0	0	10	0.00	240.44	0.00	0.00	0.00
14	239.27	20.85	49.89	0	10	0	0	0	10	0.00	239.27	0.00	0.00	0.00
15	185.21	21.00	38.89	0	8	0	0	0	8	0.00	185.21	0.00	0.00	0.00
16														
17														
18	191.72	20.40	39.11	0	0	0	8	0	8	0.00	0.00	0.00	191.72	0.00
19	192.24	21.40	41.14	0	0	0	8	0	8	0.00	0.00	0.00	192.24	0.00
20	216.14	20.60	44.52	0	0	0	9	0	9	0.00	0.00	0.00	216.14	0.00
21	240.42	20.75	49.89	0	0	0	10	0	10	0.00	0.00	0.00	240.42	0.00
22	142.59	20.10	28.66	0	0	0	5	0	5	0.00	0.00	0.00	142.59	0.00
23														
24														
25	190.15	20.05	38.13	0	8	0	0	0	8	0.00	190.15	0.00	0.00	0.00
26	189.70	21.00	39.84	0	8	0	0	0	8	0.00	189.70	0.00	0.00	0.00
27	190.50	21.25	40.48	0	8	0	0	0	8	0.00	190.50	0.00	0.00	0.00
28	189.46	21.00	39.79	0	8	0	0	0	8	0.00	189.46	0.00	0.00	0.00
29	149.10	22.35	33.32	0	6	0	0	0	6	0.00	149.10	0.00	0.00	0.00
30														
31														
TOTAL	4262.54	20.71	876.37	0	133	0	44	0	177	0.00	3183.36	0.00	1079.18	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

February			2021									
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Compost
1	168.77	22.25	37.55	0	7	0	0	7	0.00	168.77	0.00	0.00
2	241.55	20.90	50.48	0	10	0	0	10	0.00	241.55	0.00	0.00
3	193.29	21.95	42.43	0	8	0	0	8	0.00	193.29	0.00	0.00
4	241.62	21.80	52.67	0	10	0	0	10	0.00	241.62	0.00	0.00
5	119.05	21.65	25.77	0	5	0	0	5	0.00	119.05	0.00	0.00
6												
7												
8	96.62	21.00	20.29	0	4	0	0	4	0.00	96.62	0.00	0.00
9	265.56	21.85	58.02	0	11	0	0	11	0.00	265.56	0.00	0.00
10	192.69	20.60	39.69	0	8	0	0	8	0.00	192.69	0.00	0.00
11	218.55	20.50	44.80	0	9	0	0	9	0.00	218.55	0.00	0.00
12	193.53	21.52	41.65	0	8	0	0	8	0.00	193.53	0.00	0.00
13												
14												
15	195.91	21.52	42.16	0	8	0	0	8	0.00	195.91	0.00	0.00
16	144.79	21.52	31.16	0	6	0	0	6	0.00	144.79	0.00	0.00
17	266.84	20.70	55.24	0	11	0	0	11	0.00	266.84	0.00	0.00
18	314.48	21.00	66.04	0	13	0	0	13	0.00	314.48	0.00	0.00
19	192.44	21.52	41.41	0	8	0	0	8	0.00	192.44	0.00	0.00
20												
21												
22	266.28	22.70	60.45	0	11	0	0	11	0.00	266.28	0.00	0.00
23	193.98	22.80	44.23	0	8	0	0	8	0.00	193.98	0.00	0.00
24	242.32	21.52	52.15	0	10	0	0	10	0.00	242.32	0.00	0.00
25	288.42	21.52	62.07	0	12	0	0	12	0.00	288.42	0.00	0.00
26	115.74	21.52	24.91	0	5	0	0	5	0.00	115.74	0.00	0.00
27												
28												
TOTAL	4152.43	21.52	893.17	0	172	0	0	172	0.00	4152.43	0.00	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

March			2021											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1	166.39	27.65	46.01	0	7	0	0	0	7	0.00	166.39	0.00	0.00	0.00
2	240.40	41.60	100.01	0	10	0	0	0	10	0.00	240.40	0.00	0.00	0.00
3	120.31	27.65	33.27	0	5	0	0	0	5	0.00	120.31	0.00	0.00	0.00
4	361.28	27.65	99.89	0	15	0	0	0	15	0.00	361.28	0.00	0.00	0.00
5	193.09	24.05	46.44	0	8	0	0	0	8	0.00	193.09	0.00	0.00	0.00
6														
7														
8	240.66	26.00	62.57	0	10	0	0	0	10	0.00	240.66	0.00	0.00	0.00
9	212.44	26.50	56.30	0	2	0	7	0	9	0.00	47.30	0.00	165.14	0.00
10	239.90	25.85	62.01	0	0	0	10	0	10	0.00	0.00	0.00	239.90	0.00
11	72.49	26.95	19.54	0	0	0	3	0	3	0.00	0.00	0.00	72.49	0.00
12	335.85	27.70	93.03	0	14	0	0	0	14	0.00	335.85	0.00	0.00	0.00
13	143.53	27.65	39.69	0	6	0	0	0	6	0.00	143.53	0.00	0.00	0.00
14														
15	288.02	27.65	79.64	0	12	0	0	0	12	0.00	288.02	0.00	0.00	0.00
16	263.89	25.15	66.37	0	11	0	0	0	11	0.00	263.89	0.00	0.00	0.00
17	215.73	27.65	59.65	0	9	0	0	0	9	0.00	215.73	0.00	0.00	0.00
18	190.4	27.65	52.65	0	8	0	0	0	8	0.00	190.4	0.00	0.00	0.00
19	143.90	28.10	40.44	0	6	0	0	0	6	0.00	143.90	0.00	0.00	0.00
20														
21														
22	291.73	28.55	83.29	0	12	0	0	0	12	0.00	291.73	0.00	0.00	0.00
23	213.23	27.65	58.96	0	10	0	0	0	10	0.00	213.23	0.00	0.00	0.00
24	216.04	25.55	55.20	0	9	0	0	0	9	0.00	216.04	0.00	0.00	0.00
25	145.09	25.50	37.00	0	6	0	0	0	6	0.00	145.09	0.00	0.00	0.00
26	119.75	27.65	33.11	0	5	0	0	0	5	0.00	119.75	0.00	0.00	0.00
27														
28														
29	311.35	26.85	83.60	0	13	0	0	0	13	0.00	311.35	0.00	0.00	0.00
30	215.34	26.75	57.60	0	9	0	0	0	9	0.00	215.34	0.00	0.00	0.00
31	259.85	29.60	76.92	0	11	0	0	0	11	0.00	259.85	0.00	0.00	0.00
TOTAL	5200.66	27.65	1443.15	0	198	0	20	0	218	0.00	4723.13	0.00	477.53	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

April			2021									
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Compost
1	96.82	26.85	26.00	0	4	0	0	4	0.00	96.82	0.00	0.00
2												
3												
4												
5	216.55	28.55	61.83	0	9	0	0	9	0.00	216.55	0.00	0.00
6	336.85	26.05	87.75	0	14	0	0	14	0.00	336.85	0.00	0.00
7	288.37	24.10	69.50	0	12	0	0	12	0.00	288.37	0.00	0.00
8	219.60	28.55	62.70	0	9	0	0	9	0.00	219.60	0.00	0.00
9	114.88	25.95	29.81	0	5	0	0	5	0.00	114.88	0.00	0.00
10												
11												
12	287.76	28.75	82.73	0	12	0	0	12	0.00	287.76	0.00	0.00
13	239.13	29.45	70.42	0	10	0	0	10	0.00	239.13	0.00	0.00
14	237.54	31.05	73.76	0	10	0	0	10	0.00	237.54	0.00	0.00
15	118.18	29.35	34.69	0	5	0	0	5	0.00	118.18	0.00	0.00
16	164.92	29.00	47.83	0	7	0	0	7	0.00	164.92	0.00	0.00
17												
18												
19	218.52	28.55	62.39	0	9	0	0	9	0.00	218.52	0.00	0.00
20	288.86	30.20	87.24	0	12	0	0	12	0.00	288.86	0.00	0.00
21	214.03	28.55	61.11	0	9	0	0	9	0.00	214.03	0.00	0.00
22	141.71	29.60	41.95	0	6	0	0	6	0.00	141.71	0.00	0.00
23	143.55	32.10	46.08	0	6	0	0	6	0.00	143.55	0.00	0.00
24												
25												
26	239.75	28.70	68.81	0	10	0	0	10	0.00	239.75	0.00	0.00
27	190.70	28.55	54.44	0	8	0	0	8	0.00	190.70	0.00	0.00
28	143.51	29.30	42.05	0	6	0	0	6	0.00	143.51	0.00	0.00
29	239.91	27.85	66.81	0	10	0	0	10	0.00	239.91	0.00	0.00
30	115.70	28.55	33.03	0	5	0	0	5	0.00	115.70	0.00	0.00
TOTAL	4256.84	28.55	1210.90	0	178	0	0	178	0.00	4256.84	0.00	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

May			**2021**											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1														
2														
3	217.13	26.95	58.52	0	0	0	0	9	9	0.00	0.00	0.00	0.00	217.13
4	264.77	24.80	65.66	0	0	0	0	11	11	0.00	0.00	0.00	0.00	264.77
5	239.86	24.80	59.49	0	0	0	0	10	10	0.00	0.00	0.00	0.00	239.86
6	96.05	25.05	24.06	0	0	0	0	4	4	0.00	0.00	0.00	0.00	96.05
7	137.70	26.65	36.70	0	0	0	0	6	6	0.00	0.00	0.00	0.00	137.70
8														
9														
10	217.43	25.05	54.47	0	0	0	0	9	9	0.00	0.00	0.00	0.00	217.43
11	193.23	23.95	46.28	0	0	0	8	0	8	0.00	0.00	0.00	193.23	0.00
12	193.05	24.80	47.88	0	0	0	8	0	8	0.00	0.00	0.00	193.05	0.00
13	119.78	24.20	28.99	0	0	0	5	0	5	0.00	0.00	0.00	119.78	0.00
14	265.02	25.05	66.39	0	0	0	11	0	11	0.00	0.00	0.00	265.02	0.00
15														
16														
17	257.96	25.05	64.62	0	0	0	11	0	11	0	0	0.00	257.96	0.00
18	232.41	25.05	58.22	0	0	0	10	0	10	0.00	0.00	0.00	232.41	0.00
19	254.48	25.05	63.75	0	0	0	11	0	11	0.00	0.00	0.00	254.48	0.00
20	277.13	23.45	64.99	0	0	0	12	0	12	0.00	0.00	0.00	277.13	0.00
21	164.09	23.25	38.15	0	0	0	7	0	7	0.00	0.00	0.00	164.09	0.00
22														
23														
24	282.99	25.05	70.89	0	0	0	12	0	12	0.00	0.00	0.00	282.99	0.00
25	231.98	25.40	58.92	0	0	0	10	0	10	0.00	0.00	0.00	231.98	0.00
26	259.27	25.45	65.98	0	0	0	11	0	11	0.00	0.00	0.00	259.27	0.00
27	211.06	25.90	54.66	0	0	0	9	0	9	0.00	0.00	0.00	211.06	0.00
28	256.95	26.00	66.81	0	0	0	11	0	11	0.00	0.00	0.00	256.95	0.00
29	144.35	25.05	36.16	0	0	0	6	0	6	0.00	0.00	0.00	144.35	0.00
30														
31	240.75	25.05	60.31	0	10	0	10	0	20	0.00	0.00	0.00	240.75	0.00
TOTAL	4757.44	25.05	1191.87	0	10	0	152	49	211	0.00	0.00	0.00	3584.50	1172.94

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

June			**2021**											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1	264.42	24.85	65.71	0	0	0	11	0	11	0.00	0.00	0.00	264.42	0.00
2	240.62	24.70	59.43	0	0	0	10	0	10	0.00	0.00	0.00	240.62	0.00
3	214.74	25.90	55.62	0	0	0	9	0	9	0.00	0.00	0.00	214.74	0.00
4	192.91	26.90	51.89	0	0	0	8	0	8	0.00	0.00	0.00	192.91	0.00
5														
6														
7	263.62	24.70	65.11	0	0	11	0	0	11	0.00	0.00	263.62	0.00	0.00
8	286.05	25.52	73.00	0	0	12	0	0	12	0.00	0.00	286.05	0.00	0.00
9	282.95	25.52	72.21	0	0	12	0	0	12	0.00	0.00	282.95	0.00	0.00
10	120.71	25.45	30.72	0	0	4	1	0	5	0.00	0.00	96.30	24.41	0.00
11	212.46	25.52	54.22	0	0	0	9	0	9	0.00	0.00	0.00	212.46	0.00
12														
13														
14	236.68	26.85	63.55	0	0	0	10	0	10	0.00	0.00	0.00	236.68	0.00
15	229.46	26.20	60.12	0	0	0	10	0	10	0.00	0.00	0.00	229.46	0.00
16	275.98	25.52	70.43	0	0	12	0	0	12	0.00	0.00	275.98	0.00	0.00
17	116.56	27.05	31.53	0	0	5	0	0	5	0.00	0.00	116.56	0.00	0.00
18	137.78	26.60	36.65	0	0	6	0	0	6	0.00	0.00	137.78	0.00	0.00
19														
20														
21	157.91	25.65	40.50	0	0	7	0	0	7	0.00	0.00	157.91	0.00	0.00
22	119.59	25.15	30.08	0	0	6	0	0	6	0.00	0.00	119.59	0.00	0.00
23	339.44	25.30	85.88	0	0	14	0	0	14	0.00	0.00	339.44	0.00	0.00
24	193.31	24.35	47.07	0	0	8	0	0	8	0.00	0.00	193.31	0.00	0.00
25	192.19	24.65	47.37	0	0	8	0	0	8	0.00	0.00	192.19	0.00	0.00
26														
27														
28	292.09	25.30	73.90	0	0	12	0	0	12	0.00	0.00	292.09	0.00	0.00
29	192.19	25.60	49.20	0	0	8	0	0	8	0.00	0.00	192.19	0.00	0.00
30	282.82	24.20	68.44	0	0	12	0	0	12	0.00	0.00	282.82	0.00	0.00
TOTAL	4844.48	25.52	1232.64	0	0	137	68	0	205	0.00	0.00	3228.78	1615.70	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

July			2021											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1	144.43	22.04	31.83	0	0	6	0	0	6	0.00	0.00	144.43	0.00	0.00
2														
3														
4														
5	193.21	22.04	42.58	0	0	8	0	0	8	0.00	0.00	193.21	0.00	0.00
6	241.13	22.04	53.15	0	0	10	0	0	10	0.00	0.00	241.13	0.00	0.00
7	264.35	22.04	58.26	0	0	11	0	0	11	0.00	0.00	264.35	0.00	0.00
8	239.43	22.75	54.47	0	0	10	0	0	10	0.00	0.00	239.43	0.00	0.00
9	288.01	22.04	63.48	0	0	12	0	0	12	0.00	0.00	288.01	0.00	0.00
10														
11														
12	217.15	23.10	50.16	0	0	9	0	0	9	0.00	0.00	217.15	0.00	0.00
13	311.81	21.75	67.82	0	0	13	0	0	13	0.00	0.00	311.81	0.00	0.00
14	120.37	20.50	24.68	0	0	5	0	0	5	0.00	0.00	120.37	0.00	0.00
15	96.65	21.00	20.30	0	0	4	0	0	4	0.00	0.00	96.65	0.00	0.00
16	121.56	22.50	27.35	0	0	5	0	0	5	0.00	0.00	121.56	0.00	0.00
17														
18														
19	96.32	26.40	25.43	0	0	4	0	0	4	0.00	0.00	96.32	0.00	0.00
20	48.38	22.50	10.89	0	0	2	0	0	2	0.00	0.00	48.38	0.00	0.0
21														
22	359.50	21.95	78.91	0	0	0	15	0	15	0.00	0.00	0.00	359.50	0.00
23	216.61	21.40	46.35	0	0	0	9	0	9	0.00	0.00	0.00	216.61	0.00
24														
25														
26	256.86	21.00	53.94	0	0	11	0	0	11	0.00	0.00	256.86	0.00	0.00
27	191.87	20.90	40.10	0	0	8	0	0	8	0.00	0.00	191.87	0.00	0.00
28	144.67	19.90	28.79	0	0	6	0	0	6	0.00	0.00	144.67	0.00	0.00
29	174.09	22.05	38.39	0	0	6	0	0	6	0.00	0.00	174.09	0.00	0.00
30	171.30	22.85	39.14	0	0	7	0	0	7	0.00	0.00	171.30	0.00	0.00
31														
TOTAL	3897.70	22.04	856.01	0	0	137	24	0	161	0.00	0.00	3321.59	576.11	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

August			2021											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1														
2														
3	288.85	21.90	63.26	0	0	12	0	0	12	0.00	0.00	288.85	0.00	0.00
4	264.60	21.65	57.29	0	0	11	0	0	11	0.00	0.00	264.60	0.00	0.00
5	215.98	22.00	47.52	0	0	9	0	0	9	0.00	0.00	215.98	0.00	0.00
6	121.75	21.75	26.48	0	0	5	0	0	5	0.00	0.00	121.75	0.00	0.00
7														
8														
9	144.20	21.40	30.86	0	0	3	3	0	6	0.00	0.00	72.15	72.06	0.00
10	265.49	20.70	54.96	0	0	10	1	0	11	0.00	0.00	240.35	25.13	0.00
11	238.99	22.70	54.25	0	0	7	3	0	10	0.00	0.00	167.63	71.36	0.00
12	236.62	22.35	52.88	0	0	10	0	0	10	0.00	0.00	236.62	0.00	0.00
13	182.45	21.90	39.96	0	0	8	0	0	8	0.00	0.00	182.45	0.00	0.00
14														
15														
16	264.32	23.10	61.06	0	0	11	0	0	11	0.00	0.00	264.32	0.00	0.00
17	216.66	23.25	50.37	0	0	9	0	0	9	0.00	0.00	216.66	0.00	0
18	214.79	23.05	49.51	0	0	9	0	0	9	0	0.00	214.79	0.00	0
19	141.35	22.15	31.31	0	0	6	0	0	6	0.00	0.00	141.35	0.00	0.00
20	69.02	22.25	15.36	0	0	3	0	0	3	0.00	0.00	69.02	0.00	0.00
21														
22														
23	244.92	22.70	55.60	0	0	0	10	0	10	0.00	0.00	0.00	244.92	0.00
24	291.64	24.65	71.89	0	0	2	9	0	11	0.00	0.00	48.23	243.40	0.00
25	217.57	24.65	53.63	0	0	9	0	0	9	0.00	0.00	217.57	0.00	0.00
26	214.37	25.20	54.02	0	0	9	0	0	9	0.00	0.00	214.37	0.00	0.00
27	144.38	24.90	35.95	0	0	6	0	0	6	0.00	0.00	144.38	0.00	0.00
28														
29														
30	216.87	24.85	53.89	0	0	9	0	0	9	0.00	0.00	216.87	0.00	0.00
31	287.68	24.75	71.20	0	0	12	0	0	12	0.00	0.00	287.68	0.00	0.00
TOTAL	4482.49	22.95	960.03	0	0	160	26	0	186	0.00	0.00	3825.61	656.88	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

September			**2021**									
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Compost
1	133.74	24.80	33.17	0	0	6	0	6	0.00	0.00	133.74	0.00
2	72.14	25.00	18.03	0	0	3	0	3	0.00	0.00	72.14	0.00
3	138.96	26.00	36.13	0	0	6	0	6	0.00	0.00	138.96	0.00
4												
5												
6												
7	264.27	24.20	63.95	0	0	11	0	11	0.00	0.00	264.27	0.00
8	216.13	23.75	51.33	0	0	9	0	9	0.00	0.00	216.13	0.00
9	191.94	24.05	46.16	0	0	8	0	8	0.00	0.00	191.94	0.00
10	143.78	23.80	34.22	0	0	6	0	6	0.00	0.00	143.78	0.00
11												
12												
13	265.00	23.85	63.20	0	0	11	0	11	0.00	0.00	265.00	0.00
14	263.50	22.50	59.29	0	0	11	0	11	0.00	0.00	263.50	0.00
15	216.13	23.15	50.03	0	0	9	0	9	0.00	0.00	216.13	0.00
16	142.25	22.90	32.58	0	0	6	0	6	0.00	0.00	142.25	0.00
17	143.97	23.20	33.40	0	0	6	0	6	0.00	0.00	143.97	0.00
18												
19	46.99	23.39	10.99	0	0	2	0	2	0.00	0.00	46.99	0.00
20	118.00	22.75	26.84	0	0	5	0	5	0.00	0.00	118.00	0.00
21	261.58	21.85	57.15	0	0	11	0	11	0.00	0.00	261.58	0.00
22	287.47	22.40	64.39	0	0	12	0	12	0.00	0.00	287.47	0.00
23	235.76	23.30	54.93	0	0	10	0	10	0.00	0.00	235.76	0.00
24	141.83	23.35	33.12	0	0	6	0	6	0.00	0.00	141.83	0.00
25												
26												
27	238.14	22.25	52.99	0	0	10	0	10	0.00	0.00	238.14	0.00
28	165.49	22.20	36.74	0	0	7	0	7	0.00	0.00	165.49	0.00
29	166.42	22.40	37.28	0	0	7	0	7	0.00	0.00	166.42	0.00
30	213.93	23.39	50.04	0	0	9	0	9	0.00	0.00	213.93	0.00
TOTAL	4067.40	23.39	945.97	0	0	171	0	171	0.00	0.00	4067.40	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

October			2021											
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Brady S.F.	Wet Cake Compost
1	212.54	22.00	46.76	0	0	9	0	0	9	0.00	0.00	212.54	0.00	0
2														
3														
4	166.33	21.90	36.43	0	0	7	0	0	7	0.00	0.00	166.33	0.00	0.00
5	213.96	22.10	47.28	0	0	9	0	0	9	0.00	0.00	213.96	0.00	0.00
6	165.80	21.80	36.15	0	0	7	0	0	7	0.00	0.00	165.80	0.00	0.00
7	237.44	21.30	50.57	0	0	10	0	0	10	0.00	0.00	237.44	0.00	0.00
8	235.43	20.90	49.20	0	0	10	0	0	10	0.00	0.00	235.43	0.00	0.00
9														
10														
11	166.37	22.14	36.83	0	0	0	7	0	7	0.00	0.00	0.00	166.37	0.00
12	189.51	22.05	41.79	0	0	8	0	0	8	0.00	0.00	189.51	0.00	0.00
13	218.08	22.40	48.85	0	0	0	9	0	9	0.00	0.00	0.00	218.08	0.00
14	237.42	22.40	53.18	0	0	0	10	0	10	0.00	0.00	0.00	237.42	0.00
15	190.55	22.55	42.97	0	0	0	8	0	8	0.00	0.00	0.00	190.55	0.00
16														
17														
18	188.06	23.05	43.35	0	0	8	0	0	8	0.00	0.00	188.06	0.00	0.00
19	233.33	22.60	52.73	0	0	10	0	0	10	0.00	0.00	233.33	0.00	0.00
20	232.36	22.60	52.51	0	0	10	0	0	10	0.00	0.00	232.36	0.00	0.00
21	275.06	22.10	60.79	0	0	12	0	0	12	0.00	0.00	275.06	0.00	0.00
22	138.31	22.80	31.54	0	0	6	0	0	6	0.00	0.00	138.31	0.00	0.00
23														
24														
25	247.53	22.50	55.69	0	10	0	0	0	10	0.00	247.53	0.00	0.00	0.00
26	295.34	22.20	65.56	0	12	0	0	0	12	0.00	295.34	0.00	0.00	0.00
27	172.86	21.70	37.51	0	7	0	0	0	7	0.00	172.86	0.00	0.00	0.00
28	197.17	21.55	42.49	0	8	0	0	0	8	0.00	197.17	0.00	0.00	0.00
29	120.87	22.20	26.83	0	5	0	0	0	5	0.00	120.87	0.00	0.00	0.00
30														
31														
TOTAL	4334.32	22.14	959.03	0	42	106	34	0	182	0.00	1033.77	2488.12	812.43	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

November			2021									
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Compost
1	297.37	22.54	67.03	0	12	0	0	12	0.00	297.37	0.00	0.00
2	246.24	22.54	55.50	0	10	0	0	10	0.00	246.24	0.00	0.00
3	146.36	22.10	32.34	0	6	0	0	6	0.00	146.36	0.00	0.00
4	171.58	22.05	37.83	0	7	0	0	7	0.00	171.58	0.00	0.00
5	143.85	22.95	33.01	0	6	0	0	6	0.00	143.85	0.00	0.00
6												
7												
8	174.68	22.85	39.91	0	7	0	0	7	0.00	174.68	0.00	0.00
9	290.33	22.65	65.76	0	12	0	0	12	0.00	290.33	0.00	0.00
10	142.64	23.15	33.02	0	6	0	0	6	0.00	142.64	0.00	0.00
11												
12												
13	219.33	22.54	49.44	0	9	0	0	9	0.00	219.33	0.00	0.00
14												
15	164.96	23.80	39.26	0	7	0	0	7	0.00	164.96	0.00	0.00
16	190.03	22.85	43.42	0	8	0	0	8	0.00	190.03	0.00	0.00
17	189.237	23.05	43.62	0	8	0	0	8	0.00	189.24	0.00	0.00
18	212.71	22.90	48.71	0	9	0	0	9	0.00	212.71	0.00	0.00
19	185.09	22.55	41.74	0	8	0	0	8	0.00	185.09	0.00	0.00
20												
21												
22	120.18	22.70	27.28	0	5	0	0	5	0.00	120.18	0.00	0.00
23	189.05	21.95	41.50	0	8	0	0	8	0.00	189.05	0.00	0.00
24	234.85	22.00	51.67	0	10	0	0	10	0.00	234.85	0.00	0.00
25	186.64	22.45	41.90	0	8	0	0	8	0.00	186.64	0.00	0.00
26	187.19	22.25	41.65	0	8	0	0	8	0.00	187.19	0.00	0.00
27												
28												
29	258.72	22.20	57.44	0	11	0	0	11	0.00	258.72	0.00	0.00
30	187.44	21.20	39.74	0	8	0	0	8	0.00	187.44	0.00	0.00
TOTAL	4138.46	22.54	931.77	0	173	0	0	173	0.00	4138.46	0.00	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

December			2021									
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab	Wet Cake Land App	Wet Cake Compost
1	210.68	21.59	45.48	0	9	0	0	9	0.00	210.68	0.00	0.00
2	208.68	21.59	45.05	0	9	0	0	9	0.00	208.68	0.00	0.00
3	139.09	21.59	30.03	0	6	0	0	6	0.00	139.09	0.00	0.00
4												
5												
6	233.87	21.59	50.49	0	10	0	0	10	0.00	233.87	0.00	0.00
7	137.70	22.25	30.64	0	6	0	0	6	0.00	137.70	0.00	0.00
8	23.54	22.60	5.32	0	1	0	0	1	0.00	23.54	0.00	0.00
9	48.18	19.60	9.44	0	2	0	0	2	0.00	48.18	0.00	0.00
10	96.00	21.30	20.45	0	4	0	0	4	0.00	96.00	0.00	0.00
11												
12												
13	237.10	21.59	51.19	0	10	0	0	10	0.00	237.10	0.00	0.00
14	237.09	20.95	49.67	0	10	0	0	10	0.00	237.09	0.00	0.00
15	238.10	20.95	49.88	0	10	0	0	10	0.00	238.10	0.00	0.00
16	189.34	21.40	40.52	0	8	0	0	8	0.00	189.34	0.00	0.00
17	165.85	22.65	37.57	0	7	0	0	7	0.00	165.85	0.00	0.00
18												
19												
20	165.20	22.05	36.43	0	7	0	0	7	0.00	165.20	0.00	0.00
21	213.92	21.75	46.53	0	9	0	0	9	0.00	213.92	0.00	0.00
22	140.41	20.60	28.93	0	6	0	0	6	0.00	140.41	0.00	0.00
23	354.77	21.85	77.52	0	15	0	0	15	0.00	354.77	0.00	0.00
24	191.30	22.05	42.18	0	8	0	0	8	0.00	191.30	0.00	0.00
25												
26												
27	238.09	21.59	51.40	0	10	0	0	10	0.00	238.09	0.00	0.00
28	143.95	21.59	31.08	0	6	0	0	6	0.00	143.95	0.00	0.00
29	144.46	21.40	30.92	0	6	0	0	6	0.00	144.46	0.00	0.00
30	215.85	21.85	47.16	0	9	0	0	9	0.00	215.85	0.00	0.00
31	240.47	22.25	53.50	0	10	0	0	10	0.00	240.47	0.00	0.00
TOTAL	4213.61	21.59	911.37	0	178	0	0	178	0.00	4213.61	0.00	0.00

NOTES:

No information available, monthly average used.

2021 Biosolids Management Program

January - December 2021 NEWPCC Scale										Wet Tonnes				
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Soil Fab	Loads to Land App	Loads to Brady S.F.	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab (Summit)	Wet Cake Soil Fab (BRRMF)	Wet Cake Land App	Wet Cake Compost
TOTAL	52608.36	23.64	12412.29	0	1084	711	368	49	2212	0.00	25701.59	8802.33	16931.50	1172.94

January - December 2021 NEWPCC and BRRMF Scales										Wet Tonnes				
Date	Wet Cake	% Total Solids	Dry Cake	Loads to Landfill	Loads for Fab (Sum	Loads for Fab (BRR	Loads to Land App	Loads to Compost	Loads Total	Wet Cake Landfill	Wet Cake Soil Fab (Summit)	Wet Cake Soil Fab (BRRMF)	Wet Cake Land App	Wet Cake Compost
TOTAL	52492.66	23.64	12409.26	0	1084	711	368	49	2212	0.00	25701.59	8793.30	16931.50	1066.27

NOTES:

Derived from weigh scales at BRRMF, considered more accurate than NEWPCC scale system.

Calculated using a combination of BRRMF scale weights (BRRMF soil fab, compost, and landfill) and NEWPCC volumes (Summit soil fab and land app).