Utah Division of Water Quality
Statement of Basis
ADDENDUM
Wasteload Analysis and Antidegradation Level I Review

Date: **April 16, 2020**

Facility: **Castle Dale Wastewater Treatment Facility**
Castle Valley Special Service District
UPDES No. UT0026663

Receiving water: **Cottonwood Creek (2B, 3C, 4)**

This addendum summarizes the wasteload analysis that was performed to determine water quality based effluent limits (WQBEL) for this discharge. Wasteload analyses are performed to determine point source effluent limitations necessary to maintain designated beneficial uses by evaluating projected effects of discharge concentrations on in-stream water quality. The wasteload analysis also takes into account downstream designated uses (UAC R317-2-8). Projected concentrations are compared to numeric water quality standards to determine acceptability. The numeric criteria in this wasteload analysis may be modified by narrative criteria and other conditions determined by staff of the Division of Water Quality.

Discharge
Outfall 001: Cottonwood Creek

The maximum daily design discharge is 0.95 MGD and the maximum monthly design discharge is 0.70 MGD for the facility.

Effluent parameters were characterized using data from monitoring site 4930900 Castle Dale Lagoons Outfall.

Receiving Water
The receiving water for Outfall 001 is Cottonwood Creek, which is tributary to Huntington Creek, which drains to the San Rafael River and the Colorado River.

Per UAC R317-2-13.1(b), the designated beneficial uses for Cottonwood Creek from confluence with Huntington Creek to Highway U-57 crossing are 2B, 3C and 4.

- *Class 2B - Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.*
- *Class 3C - Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.*
- *Class 4 - Protected for agricultural uses including irrigation of crops and stock watering.*

Typically, the critical flow for the wasteload analysis is considered the lowest stream flow for seven consecutive days with a ten year return frequency (7Q10). Due to a lack of flow records

for Cottonwood Creek, the 20th percentile of flow measurements taken upstream of the outfall at the Highway U-10 crossing was calculated to estimate annual critical flow in the receiving water (Table 1).

Table 1: Annual critical low flow for Cottonwood Creek at U-10 crossing

Season	Flow (cfs)
Annual	0.3

Receiving water quality data were obtained from monitoring site 4930930 Cottonwood Creek at U-10 Crossing in Castle Dale. The average seasonal value was calculated for each constituent with available data in the receiving water.

Mixing Zone

Per UAC R317-2-5, a discharge is considered instantaneously fully mixed if the discharge is more than twice the ambient flow. Therefore, no mixing zone is granted for this discharge.

Parameters of Concern

The potential parameters of concern identified for the discharge/receiving water were total suspended solids (TSS), dissolved oxygen (DO), BOD_5, total phosphorus (TP), total nitrogen (TN), total ammonia (NH3-N), E. coli, pH, and total residual chlorine (TRC) as determined in consultation with the UPDES Permit Writer.

TMDL

Cottonwood Creek from the confluence with Huntington Creek to Highway 57was listed as impaired for pH according to the 303(d) list in *Utah's 2016 Integrated Report*. The San Rafael River downstream of the confluence with Cottonwood Creek is listed as impaired for benthic macroinvertebrates.

Per UAC R317-2-14, Cottonwood Creek from the confluence with Huntington Creek to U-57 has a site specific criterion for TDS concentration of 3,500 mg/L that is based upon the EPA approved Total Maximum Daily Load (TMDL) *Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids, West Colorado Watershed Management Unit, Utah* (MFG Inc., 2004).

WET Limits

The percent of effluent in the receiving water in a fully mixed condition, and acute and chronic dilution in a not fully mixed condition are calculated in the WLA in order to generate WET limits. The LC_{50} (lethal concentration, 50%) percent effluent for acute toxicity and the IC_{25} (inhibition concentration, 25%) percent effluent for chronic toxicity, as determined by the WET test, needs to be below the WET limits, as determined by the WLA. The WET limit for LC_{50} is typically 100% effluent and does not need to be determined by the WLA.

Table 2: WET Limits for IC_{25}

Season	Percent Effluent
Annual	78%

Water Quality Modeling

Effluent limits for conservative pollutants were determined using a mass balance mixing analysis (UDWQ 2012). The inputs and results of the mass balance analysis is summarized in Appendix A.

The water quality standard for chronic ammonia toxicity is dependent on temperature and pH, and the water quality standard for acute ammonia toxicity is dependent on pH. The AMMTOX Model developed by University of Colorado and adapted by Utah DWQ and EPA Region VIII was used to determine ammonia effluent limits (Lewis et al. 2002). The analysis is summarized in Appendix B.

The effluent limits for DO and BOD_5 in order to meet minimum DO criteria in the receiving water was evaluated using the Utah River Model. The analysis is summarized in Appendix B.

The limits for total residual chlorine were determined assuming a decay rate of 20 /day (at 20 ºC) and a travel time of 8.3 minutes in the outlet pipe prior to discharge to Cottonwood Creek (approximately 1000 linear feet at 0.5 feet per second velocity). The analysis for TRC is summarized in Appendix C.

Model and supporting documentation are available for review upon request.

Effluent Limits

Select WQBELs are summarized in Table 3. The complete list of WQBELs is attached in the appendices.

Table 3: Water Quality Based Effluent Limits Summary

Effluent Constituent	Acute			Chronic		
	Standard	Limit	Averaging Period	Standard	Limit	Averaging Period
Flow (MGD)		0.95	1 day		0.70	30 days
Ammonia (mg/L)						
Summer (Jul-Sep)	9.7	16.1		2.7	4.3	
Fall (Oct-Dec)	9.7	15.4	1 hour	3.1	4.7	30 days
Winter (Jan-Mar)	9.7	14.8		3.1	4.7	
Spring (Apr-Jun)	9.7	15.9		3.1	4.8	
BOD_5 (mg/L)	N/A	35	7 days	N/A	25	30 days
Dissolved Oxygen (mg/L)	3.0	5.0	Minimum	5.0	5.0	30 days
Total Dissolved Solids (mg/L)	3,500	3,500	Maximum			
Total Residual Chlorine (mg/L)	0.019	0.024	1 hour	0.011	0.016	4 days

Antidegradation Level I Review

The objective of the Level I ADR is to ensure the protection of existing uses, defined as the beneficial uses attained in the receiving water on or after November 28, 1975. No evidence is known that the existing uses deviate from the designated beneficial uses for the receiving water. Therefore, the beneficial uses will be protected if the discharge remains below the WQBELs presented in this wasteload.

A Level II Antidegradation Review (ADR) is not required for this discharge since the pollutant concentration and load is not increasing under this permit renewal.

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Documents:

WLA Document: *CastleDaleWLA_2020-04-16.docx*
Wasteload Analysis: *CastleDaleWLA_2020.xlsm*

References:

Utah Division of Water Quality. 2012. *Utah Wasteload Analysis Procedures Version 1.0*.

Utah Division of Water Quality. 2016. *Utah's 2016 Integrated Report*.

Lewis, B., J. Saunders, and M. Murphy. 2002. *Ammonia Toxicity Model (AMMTOX, Version2): A Tool for Determining Effluent Ammonia Limits*. University of Colorado, Center for Limnology.

MFG Inc. 2004. *Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids, West Colorado Watershed Management Unit, Utah*. Utah Division of Water Quality.

DWQ-2020-009766

WASTELOAD ANALYSIS [WLA] Date: 4/16/2020

Appendix A: Mass Balance Mixing Analysis for Conservative Constituents

Discharging Facility:	Castle Dale Lagoons		
UPDES No:	UT-0026663		
Permit Flow [MGD]:	0.95	Annual	Max. Daily
	0.70	Annual	Max. Monthly
Receiving Water:	Cottonwood Creek		
Stream Classification:	2B, 3C, 4		
Stream Flows [cfs]:	0.30	All Seasons	Critical Low Flow
Fully Mixed:	YES		
Acute River Width:	100%		
Chronic River Width:	100%		

Modeling Information

A simple mixing analysis was used to determine the effluent limits.

All model numerical inputs, intermediate calculations, outputs and graphs are available for discussion, inspection and copy at the Division of Water Quality.

Effluent Limitations

Current State water quality standards are required to be met under a variety of conditions including in-stream flows targeted to the 7-day, 10-year low flow (R317-2-9).

Other conditions used in the modeling effort reflect the environmental conditions expected at low stream flows.

Effluent Limitations for Protection of Recreation (Class 2B Waters)

No dilution in unnamed irrigation ditch.

Physical Parameter	**Maximum Concentration**
pH Minimum	6.5
pH Maximum	9.0
Turbidity Increase (NTU)	10.0

Bacteriological		
E. coli (30 Day Geometric Mean)	206	(#/100 mL)
E. coli (Maximum)	668	(#/100 mL)

Effluent Limitations for Protection of Aquatic Wildlife (Assumed Class 3C Waters)

Inorganics	Chronic Standard (4 Day Average)	Acute Standard (1 Hour Average)
Parameter	Standard	Standard
Phenol (mg/L)		0.010
Hydrogen Sulfide (Undissociated) [mg/L]		0.002

Metals-Total Recoverable

	Chronic (4-day ave)			Acute (1-hour ave)		
Parameter	Standard[1]	Background	Limit	Standard[1]	Background	Limit
Aluminum (µg/L)	N/A[3]	242.3	N/A	750.0	242.3	853.6
Arsenic (µg/L)	150.0	0.9	191.3	340.0	0.9	409.2
Cadmium (µg/L)	2.4	0.05	3.0	7.4	0.05	8.9
Chromium III (µg/L)	11.0	2.0	13.5	16.0	2.0	18.9
Chromium VI (µg/L)	268.2	2.0	342.0	5,612	2.0	6,757
Copper (µg/L)	30.5	1.9	38.4	51.7	1.9	61.8
Cyanide (µg/L)[2]	5.2	3.5	5.7	22.0	3.5	25.8
Iron (µg/L)				1,000	23.0	1,199
Lead (µg/L)	18.6	0.3	23.6	477	0.3	574
Mercury (µg/L)[2]	0.012	0.008	0.013	2.4	0.008	2.9
Nickel (µg/L)	168.5	3.2	214.4	1,516	3.2	1,825
Selenium (µg/L)	4.6	0.5	5.7	18.4	0.5	22.0
Silver (µg/L)				41.1	0.3	49.4
Tributylin (µg/L)[2]	0.072	0.048	0.079	0.46	0.048	0.54
Zinc (µg/L)	387.8	6.5	493.5	387.8	6.5	465.7

1: Based upon a hardness of 400 mg/l as CaCO3

2: Background concentration assumed 67% of chronic standard

3: Where the pH is equal to or greater than 7.0 and the hardness is equal to or greater than 50 ppm as $CaC0_3$ in the receiving water after mixing, the 87 ug/L chronic criterion (expressed as total recoverable) will not apply, and aluminum will be regulated based on compliance with the 750 ug/L acute aluminum criterion (expressed as total recoverable).

Organics [Pesticides]

	Chronic (4-day ave)		Acute (1-hour ave)	
Parameter	Standard	Limit	Standard	Limit
Aldrin (µg/L)			1.5	1.5
Chlordane (µg/L)	0.0043	0.0043	1.2	1.2
DDT, DDE (µg/L)	0.001	0.001	0.55	0.55
Diazinon (µg/L)	0.17	0.17	0.17	0.17
Dieldrin (µg/L)	0.0056	0.0056	0.24	0.24
Endosulfan, a & b (µg/L)	0.056	0.056	0.11	0.11
Endrin (µg/L)	0.036	0.036	0.086	0.086
Heptachlor & H. epoxide (µg/L)	0.0038	0.0038	0.26	0.26
Lindane (µg/L)	0.08	0.08	1.0	1.0
Methoxychlor (µg/L)			0.03	0.03
Mirex (µg/L)			0.001	0.001
Nonylphenol (µg/L)	6.6	6.6	28.0	28.0
Parathion (µg/L)	0.0130	0.0130	0.066	0.066
PCB's (µg/L)	0.014	0.014		
Pentachlorophenol (µg/L)	15.0	15.0	19.0	19.0
Toxephene (µg/L)	0.0002	0.0002	0.73	0.73

Radiological Parameter	Maximum Concentration Standard
Gross Alpha (pCi/L)	15

Effluent Limitation for Protection of Agriculture (Class 4 Waters)

Parameter	Maximum Concentration Standard	Background	Limit	
Total Dissolved Solids (mg/L)	3,500	3,500	3,500	Site specific standard
Boron (µg/L)	750	83.4	935	
Arsenic, Dissolved (µg/L)	100	0.9	127	
Cadmium, Dissolved (µg/L)	10	0.1	13	
Chromium, Dissolved (µg/L)	100	2.0	127	
Copper, Dissolved (µg/L)	200	1.9	255	
Lead, Dissolved (µg/L)	100	0.3	128	
Selenium, Dissolved (µg/L)	50	0.5	64	
Gross Alpha (pCi/L)	15	0.0	19	

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Appendix B: Utah Stream DO and AMMTOX Models

Discharging Facility:	Castle Dale Lagoons		
UPDES No:	UT-0026663		
Permit Flow [MGD]:	0.70	Annual	Max. Daily
	0.95	Annual	Max. Monthly
Receiving Water:	Cottonwood Creek		
Stream Classification:	2B, 3C, 4		
Stream Flows [cfs]:	0.3	All Seasons	Critical Low Flow
Fully Mixed:	YES		
Acute River Width:	100%		
Chronic River Width:	100%		

Modeling Information

The modeling approach used in this analysis included a combination of the following models.

(1) The Utah River Model, Utah Division of Water Quality, 1992. Based upon STREAMDO IV (Region VIII) and Supplemental Ammonia Toxicity Models; EPA Region VIII, Sept. 1990 and QUAL2E (EPA, Athens, GA).

(2) AMMTOX Model, University of Colorado, Center of Limnology, and EPA Region 8

Coefficients used in the model were based, in part, upon the following references:

(1) Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling. Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens Georgia. EPA/600/3-85/040 June 1985.

(2) Principles of Surface Water Quality Modeling and Control. Robert V. Thomann, et.al. Harper Collins Publisher, Inc. 1987, pp. 644.

All model numerical inputs, intermediate calculations, outputs and graphs are available for review and comment at the Division of Water Quality.

Model Input

Current Upstream Information

Season	Critical Low Flow cfs	Temp. Deg. C	pH Ave	pH Max	NH3 mg/L as N	BOD5 mg/l	DO mg/l
Summer	0.3	16.8	8.20	8.40	0.02	1.60	6.79
Fall	0.3	4.6	8.20	8.40	0.02	1.60	9.48
Winter	0.3	5.9	8.20	8.40	0.02	1.60	10.05
Spring	0.3	14.3	8.20	8.40	0.02	1.60	7.48

	Org N mg/L as N	NO3 mg/L as N
Summer	0.25	0.32
Fall	0.25	0.32
Winter	0.25	0.32
Spring	0.25	0.32

Projected Discharge Information

Season	Flow (MGD) Max Daily	Flow (MGD) Ave Monthly	Temp. Deg. C	pH Ave	pH Max	Org N mg/L as N	NO3 mg/L as N
Summer	1.0	0.7	16.5	7.60	7.70	0.75	1.09
Fall	1.0	0.7	11.4	7.60	7.70	0.75	1.09
Winter	1.0	0.7	8.6	7.60	7.70	0.75	1.09
Spring	1.0	0.7	12.4	7.60	7.70	0.75	1.09

Effluent Limitations

Current State water quality standards are required to be met under a variety of conditions including in-stream flows targeted to the 7-day, 10-year low flow (R317-2-9).

Other conditions used in the modeling effort reflect the environmental conditions expected at low stream flows.

Effluent Limitations for Protection of Aquatic Wildlife (Assumed Class 3C Waters)

Temperature (deg C)	Maximum
Instantaneous	27.0
Change	4.0

pH	Concentration
Minimum	6.5
Maximum	9.0

Dissolved Oxygen (mg/L)	Standard	Limit
Instantaneous Minimum	3.0	5.0
30-day Average Minimum	5.0	5.0

CBOD5 (mg/L)	Standard	Limit
Daily Maximum	N/A	35.0
30-day Average	N/A	25.0

Ammonia-Total (mg/L)

Season	Chronic (30-day ave) Standard	Chronic (30-day ave) Background	Chronic (30-day ave) Limit	Acute (1-hour ave) Standard	Acute (1-hour ave) Background	Acute (1-hour ave) Limit
Summer	2.7	0.02	4.3	9.7	0.02	16.1
Fall	3.1	0.02	4.7	9.7	0.02	15.4
Winter	3.1	0.02	4.7	9.7	0.02	14.8
Spring	3.1	0.02	4.8	9.7	0.02	15.9

Model Rate Parameters and Coefficients

CBOD Kd(20) /day	CBOD Kd(T) /day	REAER. Ka(20) /day	REAER. Ka(T) /day	NBOD Kn(20) /day	NBOD Kn(T) /day
1.00	0.85	20.0	18.4	1.00	0.77

NH3 LOSS K5(20) /day	NH3 LOSS K5(T) /day	NO3 LOSS K6(20) /day	NO3 LOSS K6(T) /day	BENTHIC DEMAND SOD(20) gm/m2/day	BENTHIC DEMAND SOD(T) gm/m2/day
3.00	2.56	0.25	0.21	1.00	0.80

Kd CBOD {theta}	Ka Reaer. {theta}	Kn NH3 {theta}	K4 Open {theta}	K5 NH3 Loss {theta}	K6 NO2+3 {theta}	KCl TRC {theta}	SOD Benthic {theta}
1.047	1.024	1.08	1	1.047	1.045	1.06	1.065

WASTELOAD ANALYSIS [WLA]
Appendix C: Total Residual Chlorine

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Discharging Facility: Castle Dale Lagoons
UPDES No: UT-0026663

CHRONIC

	Season	Receiving Water	Standard	Total Effluent	Mixing Zone Boundary	Effluent Limit Without Decay	Temperature (°C)	Decay Rate (/day) @ 20 deg C	Decay Rate (/day) @ T deg C	Travel Time (min)	Decay Coefficient	Effluent Limit
Discharge (cfs)	Annual	0.3		1.1	1.4							
TRC (mg/L)	Annual	0.000	0.011			0.014	20.0	20	20.0	8.333333	0.89	0.016

ACUTE

	Season	Receiving Water	Standard	Total Effluent	Mixing Zone Boundary	Effluent Limit Without Decay	Temperature (°C)	Decay Rate (/day) @ 20 °C	Decay Rate (/day) @ T °C	Travel Time (min)	Decay Coefficient	Effluent Limit
Discharge (cfs)	Annual	0.2		1.5	1.6							
TRC (mg/L)	Annual	0.000	0.019			0.021	20.0	20	20.0	8.333333	0.89	0.024

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