BORAL CONSTRUCTION MATERIALS, LLC

QUARRY WATER MONITORING PLAN (QWMP)
2014 ANNUAL REPORT

Prepared For:

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1.0 INTRODUCTION

1.1 Background

Boral Construction Materials Oklahoma, LLC (BCM) operates a limestone quarry in Murray County roughly three (3) miles west-southwest of Davis, OK. The Roger/Chambless Mine (aka Davis Quarry) is permitted by the Oklahoma Department of Mines (ODM) (LE-1669). The quarry is an actively producing mine with a portion of the mine pit overlying the Arbuckle Simpson Aquifer, a sensitive sole source ground water basin. According to 82 O.S. §1020.2(C)(1), this facility meets the definition of an exempt mine. At this time, BCM does not hold any surface or ground water permits. A domestic ground water well is in use, but is exempt (per 82 O.S. §1020.3) from permitting and considered *de minimis*.

BCM adopted and implemented a plan to monitor the accumulation and disposition of water as required by 82 O.S. §1020.2(E)(1). A Site Specific Water Management and Conservation Plan (SSWMCP) was originally submitted to the Oklahoma Water Resources Board (OWRB) on December 28, 2012. However, with the adoption of the final rules and subsequent changes, BCM has updated its plan from a SSWMCP to a Quarry Water Monitoring Plan (QWMP). Since January 1, 2013, BCM has maintained monitoring protocols and procedures in order to assess the accumulation and disposition of Pit Water[1].

This document is designed to fulfill the annual reporting requirement specified by 82 O.S. §1020.2. The reporting period covered by this document is January through December 2014. *Information contained within this document shall be considered preliminary, draft and subject to correction, modification, and/or change.*

1.2 Facility Layout

The location of the mine pit, processing facilities, settling and retention impoundments and ancillary activities are generally illustrated on Figures 1 & 2. Figure 2 also depicts the general flow paths for the facility. Refer to Figure 3 for a generalized depiction of flow at the mine.

Refer to Figure 2 for the approximate location of mine pit water collection areas (i.e., Quarry Sumps). During this reporting period, water was pumped from two (2) sumps (North & South) within the quarry pit. The actual location and number of sumps is subject to change as needed for operating purposes.

There were no stream diversion points used during this reporting period and there were no stream discharges or ground water recharge purposefully designed for augmentation credit.

[1] Pit Water as defined by 785:30-15-2 means ground water trapped or collecting in a producing mine pit that emanates from a Sensitive Basin.

2.0 MONITORING & MEASUREMENT METHODOLOGY

BCM measured, modeled, or otherwise reasonably estimated ground water and surface water volumes entering the quarry pit sumps, along with the volume and disposition of water diverted from the sumps. As part of the QWMP, BCM has protocols to measure consumptive use, stream and ground water augmentation, precipitation, evaporation, hydrology data, and/or other sources and diversions of water (when applicable). Please note that the methods may change as needed or required. This section is a summary of various measurements and methods employed during this reporting period.

2.1 Definitions

For clarification purposes the following definitions were adopted by BCM and used throughout this document:

A. **Quarry Sump Water**[2]: Water captured or accumulated in a quarry pit sump, which may consist of ground water, surface water runoff, and/or precipitation from direct interception.
B. **Diverted Quarry Sump Water**: Water pumped out of a quarry pit sump.
C. **Pit Water**: Ground water as defined by 785:30-15-2
D. **Consumptive Use of Pit Water**: As defined by 82 O.S. §1020.2 (F)

2.2 Measuring Diverted Quarry Sump Water

Water that accumulates or collects in BCM's quarry pit sump(s) in excess quantities may be pumped to another pond or impoundment, used for dust suppression (e.g., water truck) or discharged off site. The amount of Diverted Quarry Sump Water is estimated by direct measurement and/or by calculation (e.g., operating hours of the pump multiplied by its rated capacity). Any equipment used is installed, calibrated and maintained according to manufacturer's recommendations and specifications.

During this reporting period, estimates were based on pumping hours (i.e., hours of operation) and by measured pumping volumes. The total volume diverted was calculated by multiplying pumping rate by the number of pumping hours and by adding the measured volume pumped. Daily pumping records were kept by facility staff to document the effort.

2.3 Measuring & Calculating Quarry Sump Water Components

The Pit Water (i.e., ground water) volume is determined based on the measurement or reasonable estimation of the Diverted Quarry Sump Water plus any calculated evaporation loses from the wetted surface of the sump. In order to determine what portion of the Quarry Sump Water is actual ground water (i.e., Pit Water), the various components need to be calculated. Measurement of each component is discussed below.

A. **Evaporation Component**: The volume of Quarry Sump Water lost via evaporation is calculated by monitoring evaporation and measuring the wetted surface area of the sumps. At this time there are two (2) sumps in the quarry area (North Sump & South Sump). The average surface area was field-determined and estimated for each. Evaporation data was obtained from the Sulphur, OK Mesonet station per Appendix C of OAC 785:30-15 (effective 6/13/2013)

[2] This definition is different than OAC 785:30-15-2 "pit water", but more accurately describes the water entering the mine quarry pit system.

(http://www.mesonet.org). The volume was calculated by multiplying the sump surface area by the amount/depth of evaporation (Appendix C of OAC 785:30-15).

B. **Surface Water Component**: The surface water fraction of the Quarry Sump Water is estimated by calculating runoff using accepted engineering models and/or calculations (per Appendix C, Note 3 of OAC 785:30-15). At this time, the SCS Method is used to predict storm event runoff and what portion accumulates in the sumps. The model is adjusted for the actual drainage basin characteristics (e.g., surface area, disturbance, antecedent moisture conditions, soil group (when applicable), designated land use, and growing season, etc.). The quarry sump watershed was delineated via USGS 1:24,000 topographic maps and field verification. The watershed was broken into groups based on landuse and assigned appropriate NRCS curves numbers. The calculation method followed Corbitt, R. A. "Standard Handbook of Environmental Engineering", McGraw-Hill, 1989 and Adsero, C.M, "UDOT Research Report No. UT-08.26", Brigham Young University, 2008.

   Contributing storm values were measured on site with a rain gauge and/or obtained from the Sulphur, OK Mesonet station (per Appendix C of OAC 785:30-15) (http://www.mesonet.org).

C. **Direct Interception Component:** The precipitation fraction of Quarry Sump Water is measured by determining the amount of water that is contributed by direct interception into the quarry sumps. The average surface area was determined. Precipitation is measured on site with a rain gauge and/or obtained from the Sulphur, OK Mesonet station (per Appendix C of OAC 785:30-15) (http://www.mesonet.org). The volume is calculated by multiplying the sump surface area by the amount/depth of precipitation.

D. **Ground Water Component**: The ground water or Pit Water[3] fraction is estimated by subtracting the total volume of Diverted Quarry Sump Water plus sump evaporation losses from the sum of direct interception and surface water runoff.

2.4 Measuring Consumptive Use of Pit Water

If applicable, the fraction of Pit Water (i.e., ground water) consumptively used will be calculated. The amount of water consumptively used will be determined based on the defined consumptive uses (82 O.S. §1020.2 (F)) and the guidance provided in OAC 785:30-15.

During this monitoring period no pit water was consumptively used; consequently, this section is not applicable.

2.5 Measuring Water Diverted From a Stream or Pond

During this monitoring period no water was diverted from a stream or offsite pond; consequently, this section is not applicable.

[3] As defined by 785:30-15-2

2.6 Measuring Ground Water Pumped From Water Wells

During this monitoring period, water was not pumped from a ground water well other than for domestic purposes. The ground water well associated with the facility's scale house/office is an exempt well per 82 O.S. §1020.3; consequently, this section is not applicable.

2.7 Measuring Pit Water Discharged to a Stream

During this monitoring period no Pit Water was discharged to a stream; consequently, this section is not applicable.

2.8 Measuring Water Recharged to the Aquifer

During this monitoring period no Pit Water was used to recharge the aquifer for augmentation purposes; consequently, this section is not applicable.

2.9 Precipitation at the Mine Site

Contributing precipitation values were measured on site with a rain gauge and/or obtained from the Sulphur, OK Mesonet station (per Appendix C of OAC 785:30-15) (http://www.mesonet.org). (Other Mesonet sites may be used to better estimate precipitation when applicable or necessary.)

2.10 Evaporation From All Surface Water

During this monitoring period no Pit Water was encountered; consequently, this section is not applicable.

When applicable, evaporation from other surface water ponds and impoundments that receive Pit Water (i.e., ground water) would be calculated following the guidelines developed by the OWRB (per Appendix C of OAC 785:30-15). The calculation would be similar to that used for the quarry sumps described above.

2.11 Water Obtained from Other Sources

During this monitoring period, BCM did not obtain water from other sources. However, BCM reserves the right to pursue and obtain water from any and all legally permissible sources.

3.0 RESULTS & DISCUSSION

Results of the monthly monitoring effort are summarized below.

3.1 Diverted Quarry Sump Water Volumes

As mention above, there were two (2) sumps in use at during this monitoring period—North & South. The total volume diverted was calculated in millions of gallons (MG) and acre-feet (ac-ft) from facility pumping records. The monthly and year-to-date amounts diverted from the sumps are listed in Table 3-1.

Table 3-1: North & South Sump Diversion Summary

	SUMP DIVERSIONS	
2014	NORTH & SOUTH TOTALS	
	Monthly Total (ac-ft)	Monthly Total (MG)
January	9.501	3.096
February	0.000	0.000
March	0.000	0.000
April	6.547	2.133
May	6.920	2.255
June	45.556	14.845
July	19.393	6.319
August	8.579	2.796
September	1.498	0.488
October	8.220	2.678
November	5.136	1.674
December	6.782	2.210
1st Qtr Totals	9.501	3.096
2nd Qtr Totals	59.024	19.233
3rd Qtr Totals	29.470	9.603
4th Qtr Totals	20.138	6.562
Annual Totals	118.133	38.494

3.2 Quarry Sump Water Component Volumes

A. **Evaporation Component:** The volume of Quarry Sump Water lost via evaporation was estimated using Mesonet data. Lake evaporation was calculated by multiplying the Mesonet pan evaporation by 0.7. Evaporation was calculated for both sumps and listed in Table 3-2.

Table 3-2: Sump Evaporation Summary

SUMP EVAPORATION			
2014	LAKE EVAP	NORTH & SOUTH SUMPS	
	Inches	ac-ft	MG
January	2.77	0.091	0.030
February	2.09	0.069	0.022
March	4.22	0.138	0.015
April	5.31	0.174	0.057
May	6.06	0.198	0.065
June	6.16	0.202	0.066
July	5.68	0.186	0.061
August	6.11	0.200	0.065
September	4.69	0.154	0.050
October	4.03	0.132	0.043
November	2.50	0.082	0.027
December	1.18	0.038	0.013
1st Qtr Totals	9.09	0.30	0.097
2nd Qtr Totals	17.52	0.57	0.187
3rd Qtr Totals	16.48	0.54	0.176
4th Qtr Totals	7.70	0.25	0.082
Annual Totals	50.79	1.66	0.542

B. **Surface Water Runoff Volumes:** Rainfall data was entered into the equation and the surface water fraction of the Quarry Sump Water was estimated by calculating runoff using the SCS Method as described above. Resulting runoff is reported in Table 3-3.

C. **Direct Interception (Precipitation) Volume:** Direct interception was calculated by multiplying the rainfall depth by the sump surface area and converting to MG and ac-ft. Storm water runoff and direct interception are summarized Table 3-3.

Table 3-3: Surface Water Runoff and Direct Interception Volume Summary

SURFACE WATER RUNOFF & INTERCEPTION			
2014	PRECIP	QUARRY AREA WATERSHED PLUS NORTH & SOUTH SUMPS	
	Inches	ac-ft	MG
January	0.35	0.130	0.043
February	0.25	0.127	0.041
March	2.63	10.470	3.412
April	2.55	5.305	1.729
May	5.50	25.941	8.453
June	9.85	55.205	17.989
July	6.05	26.189	8.534
August	1.85	4.656	1.517
September	3.80	13.809	4.500
October	2.25	6.545	2.133
November	4.25	19.176	6.249
December	1.10	2.021	0.659
1st Qtr Totals	3.23	10.727	3.496
2nd Qtr Totals	17.90	89.452	28.170
3rd Qtr Totals	11.70	44.653	14.550
4th Qtr Totals	7.60	27.742	9.040
Annual Totals	40.43	169.57	55.256

D. **Pit Water Volume**: As presented above, the Pit Water[4] fraction of the Diverted Quarry Sump Water is determined by subtracting the sum of sump evaporation plus sump diversion from the sum of direct interception plus surface water runoff. (Refer to Table 3-4 and Equation 3-1.) If the net balance is positive then more storm water entered the mine pit than evaporated or was pumped out. If the balance is negative, then more water evaporated or was pumped out than entered via storm water. A negative value may indicate ground water inflows. Refer to Table 3-4.

Equation 3-1: Pit Water Volume Determination:

$$(\text{Interception} + \text{Runoff}) - (\text{Sump Evaporation} + \text{Sump Diversion}) = \text{Pit Water Volume}$$

Where: A negative value ≈ Possible Pit Water Contribution
A positive value ≈ Runoff/No Pit Water Contribution

[4] As defined by 785:30-15-2

During this reporting period, there was a ~49.78 ac-ft (~16.22 MG) net positive Quarry Sump Water balance. This value suggests that there was no Pit Water contribution to the Diverted Quarry Sump Water for Water Year 2014.

Surface water runoff accumulates in the sumps during wetter periods and is pumped out during drier times giving the appearance of Pit Water influences. However, when the water balance is assessed over a relevant interval there is no overt indication of Pit Water contribution. Annual evaluation further confirms that the Quarry Sump Water is comprised of storm water.

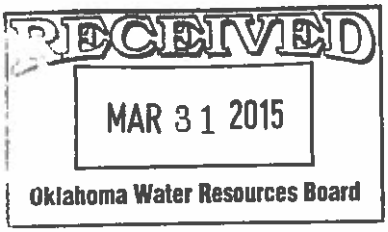
Table 3-4: Pit Water Calculation Summary

PIT WATER CALCULATION - NET BALANCE SUMMARY					
2014	Interception & Runoff	Sump Evaporation	Sump Diversion	Balance	
	MG	MG	MG	ac-ft	MG
January	0.043	0.030	3.096	-9.461	-3.083
February	0.041	0.022	0.000	0.059	0.019
March	3.412	0.045	0.000	10.331	3.367
April	1.729	0.057	2.133	-1.415	-0.461
May	8.453	0.065	2.255	18.822	6.133
June	17.989	0.066	14.845	9.448	3.078
July	8.534	0.061	6.319	6.610	2.154
August	1.517	0.065	2.796	-4.124	-1.344
September	4.500	0.050	0.488	12.157	3.962
October	2.133	0.043	2.678	-1.806	-0.589
November	6.249	0.027	1.674	13.958	4.548
December	0.659	0.013	2.210	-4.800	-1.564
1st Quarter	3.50	0.10	3.10	0.93	0.303
2nd Quarter	28.17	0.19	19.23	26.85	8.751
3rd Quarter	14.55	0.18	9.60	14.64	4.772
4th Quarter	9.04	0.08	6.56	7.35	2.396
ANNUAL TOTALS	55.256	0.542	38.494	49.779	16.221

3.3 Reporting Consumptive Use of Pit Water

Evaluation of the Quarry Sump Water disposition indicated that there did not appear to be a Pit Water contribution; therefore, no ground water was consumptively used during 2014.

4.0 FIGURES



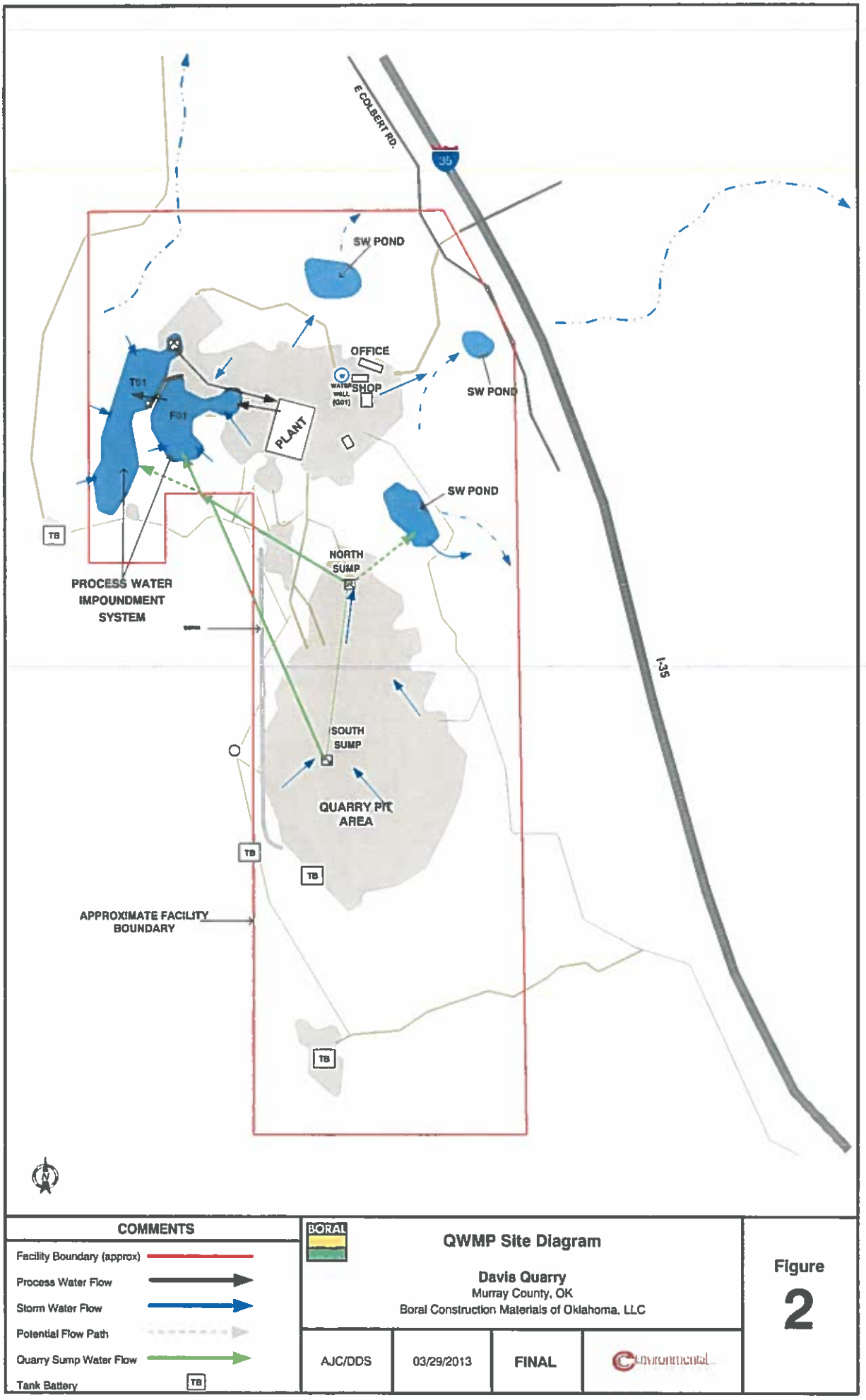
Process Water

QWMP Aerial Site Diagram
Davis Quarry

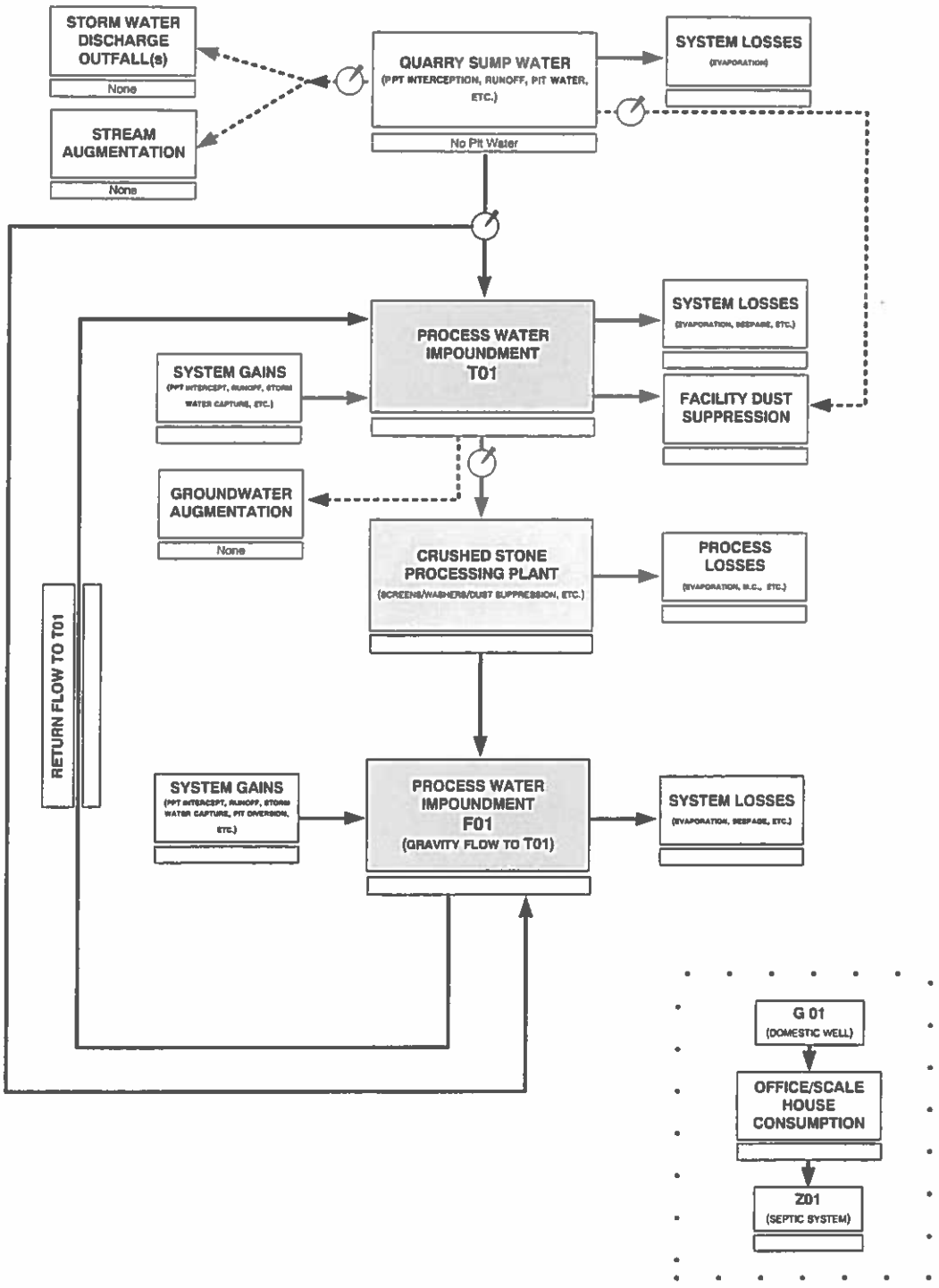
BORAL

Figure 1

Note: The diagram is partially diagrammatic; exact dimension will vary from those shown above. Not to scale.	AJC/DDS	12/26/2013	FINAL	



COMMENTS		QWMP Site Diagram			Figure
Facility Boundary (approx)	BORAL	Davis Quarry Murray County, OK Boral Construction Materials of Oklahoma, LLC			2
Process Water Flow					
Storm Water Flow					
Potential Flow Path					
Quarry Sump Water Flow					
Tank Battery TB	AJC/DDS	03/29/2013	FINAL	Environmental	



LEGEND/COMMENTS	QWMP Water Paths/Flow Schematic	Figure
Potential Flow Path ----▶ Typical Flow Path ——▶ Pump ⏲	BORAL **Davis Quarry** Murray County, OK Boral Construction Materials of Oklahoma, LLC	**3**
	AJC/DDS | 03/29/2014 | FINAL | Environmental	