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MEMORANDUM

To: Nick Batty

From: Ed Castle, PE

Date: March 1, 2018

Re: KWRU Discovery

Request: **Sludge removal expense. Please refer to Schedule CAJ-5, Page 3 (engineering estimate of biosolids production and hauling costs). Please provide all supporting documentation for the assumptions used, estimated quantities, estimated prices, and calculations.**

Sludge removal expense. Please refer to CAJ-5, Page 3 (engineering estimate of biosolids production and hauling costs). Please provide the calculations to convert AADF or drying bed tons to liquid gallons and the resulting liquid handling cost. Please provide all supporting calculations supporting the assumptions used (estimated quantities, prices, etc.)

Response:
1. The 2016 cost per ton for hauling dewatered sludge and screenings was obtained by averaging the cost per ton for one year's worth of Waste Management invoices. See files *WM Invoices 2016-17* and *May 2016 – May 2017 WM Cost Tallies 170612*. The cost per ton for each subsequent year was increased by 1.5%.
2. Cost per gallon for hauling liquid sludge was obtained from Greg Wright for 2017 costs, given as $0.30 per gallon. See file *Wright Liquid Hauling Costs 170519*. The cost per gallon for each subsequent year was increased by 1.5%.
3. Sludge production for 2016 in dry tons is based on actual operating data obtained from KWRU drying bed records provided by Greg Wright. See file *Wright Plant Loading 170519*.
4. Sludge production on the dry solids basis for 2017 through 2030 was estimated by using the actual 2016 sludge production rate in dry tons per million gallons per day of wastewater multiplied by the predicted flow in million gallons per day for each future year.
5. Predicted annual average daily flow for years 2017 through 2030 were estimated as described in the file *Future Flow Estimates 170621*.

6. The maximum dying bed dry tons was estimated based on drying bed loading data provided by KWRU. See file *Wright Drying Bed Loading 170601.* An assumption of average loading of 2000 dry pounds of sludge and a drying time of 18 days was used to estimate that a total of approximately 80 dry tons per year could be processed on the drying beds.

7. Excess dry tons is calculated by subtracting the 80 drying bed dry tons from the total dry solids tons each year.

8. Drying bed wet tons is calculated by assuming that the average harvest will be at 75% solids and that approximately 148.5 tons per year of screenings per million gallons per day of wastewater treated will be mixed with the dewatered sludge prior to hauling. The tons of screenings per year per million gallons per day was calculated by subtracting the weight of dewatered sludge from the total weight hauled by Waste Management.

9. Centrifuge wet tons is calculated by dividing the excess dry tons by 20% solids, which is typical centrifuge performance.

10. Screw press wet tons is calculated by dividing excess wet tons by 16% solids, which is typical screw press performance.

11. Liquid gallons is calculated by converting excess dry tons to pounds and then applying the formula $V = (\text{dry lbs}) / (8.34 \text{ lbs/gal} \times 20000 \text{ PPM}) \times (1000000 \text{ gal/MG})$. 20000 PPM is the assumed concentration of liquid waste activated sludge withdrawn from the WWTP digesters. 20000 PPM is the same as 2%.

12. Costs are then calculated using the cost per wet ton and the cost per liquid gallon to determine centrifuge, screw press, liquid and drying bed hauling costs.