Design Review Committee Briefing #16

Subject: Sidestream Treatment Business Case Evaluation

Date: January 11, 2019

The Issue

The sidestream treatment process serves as means for reducing phosphorus and nitrogen as well as preventing struvite buildup in key processes of a wastewater treatment plant (WWTP). Struvite is a nuisance by-product of the solids digestion process that forms through chemical reactions of magnesium, ammonium, and phosphate to produce hardened crystals. The configuration and performance of the sidestream treatment process is integral in achieving the required effluent discharge requirements for the Nampa WWTP. The Preliminary Design Technical Team conducted a business case evaluation (BCE) on the preferred sidestream treatment process. That analysis is described in this briefing.

Background and Analysis

Sidestream treatment reduces the operational challenges related to struvite accumulation (e.g. clogged pipes and mechanical equipment failures), reduces the overall nutrient loading to the secondary treatment system thereby reducing the system size, and some technologies provide an opportunity to produce a revenue-generating product. This is a rapidly evolving technology and the various approaches presented below are closely tied to specific technology providers. The technologies evaluated are described below and process flow diagrams were provided in DRC Briefing #12.

- **Alternative 1 - Centrate Precipitation with Harvesting**: Alternative 1 involves installing a sidestream treatment reactor to treat centrate, which is the liquid removed through the solids dewatering process. This is a nutrient-rich stream that comprises approximately 20 to 30 percent of the overall nutrient load for the Nampa WWTP. Alternative 1 generates struvite from the centrate and harvests it for sale through a third-party contract, which is negotiated in conjunction with the equipment process selection. This alternative produces a higher quality (and higher valued) product than other options presented.
- **Alternative 2 - Direct Chemical Addition:** Alternative 2 involves installing an expanded ferric chloride dosing system which is dosed to the process at the primary digesters. This precipitates phosphorus out of the liquid stream and allows it to be disposed of in the biosolids. This approach does not provide a means to recover a product. This alternative involves construction of chemical storage tanks, mixers, and hauling infrastructure. With this alternative, the City would experience increased operations and maintenance to address struvite-related issues such as equipment failures.
- **Alternative 3 - Centrate and WAS Precipitation with Harvesting:** Alternative 3 builds upon Alternative 1. In addition to installing a sidestream treatment reactor similar to Alternative 1, a tank is added to allow release of phosphorus from the waste activated sludge (WAS) stream prior to thickening and digestion. When compared to Alternative 1, this increases phosphorus removal from the system and increases the quantity of product that can be harvested for sale.
- **Alternative 4 - Digested Sludge Precipitation with Harvesting:** Alternative 4 is the installation of sidestream treatment between the primary anaerobic digesters and the sludge dewatering process. This approach reduces the risk of struvite accumulation on the sludge dewatering equipment (i.e. centrifuges). However, because the struvite is recovered from the digested sludge, the struvite product created is lower quality than Alternatives 1 and 3 and, therefore, has a lower potential value.

- **Alternative 5 - Digested Sludge Precipitation without Harvesting:** Alternative 5 is similar to Alternative 4 except the product is not harvested and instead is sequestered in the biosolids which are sent to a landfill. This approach reduces the costs of having to process the product to a marketable quality but does result in a loss of financial benefit from the sale of the product.

Capital costs, operating and maintenance (O&M) costs, and repair and replacement (R&R) costs were estimated for each of the alternatives. Capital costs were developed from vendor quotes and cost estimates for the required investments for each alternative. Alternative 2 had the lowest capital cost while Alternative 3 had the highest capital cost, $1.1 million and $16.9 million respectively. The wide range in capital cost estimates is due to the inclusion of a complex vendor supplied system versus the simple chemical dosing system (Alternative 2). The O&M costs encompass the expected costs associated with labor, power, and chemical usage for each alternative, as well as costs associated with solids handling and struvite maintenance. Each alternative reduces the amount of struvite that could build up in the system, however, each alternative reduces that probability to varying degrees. This varying degree of struvite prevention is captured in the struvite maintenance cost. Alternative 5 has the lowest O&M cost due to low chemical usage, lower labor requirements, and better struvite reduction which leads to lower struvite maintenance costs. R&R costs are a direct reflection of the expected useful life of the capital improvements for each alternative and are largely tied to capital cost estimates.

Risk and benefit costs for each alternative were also developed, such as regulatory, technical, safety, or financial risks/benefits. The primary risks captured in this evaluation are related to process failures or deficiencies, and product production. Alternative 2 has the highest risk cost due to high variability in the process technology, and a risk that the price of ferric chloride will increase over the planning period. Alternatives 1, 3, and 4 all incorporate a benefit cost from the revenue generated by the sale of product.

Table 1 presents the results of the sidestream treatment process BCE. The results indicate that Alternative 5 has the lowest cost of asset ownership driven primarily by lower O&M and risk costs than other alternatives. The cost of asset ownership for Alternative 2 is 0.5 percent greater than Alternative 4, which is well within the margin of error for the cost estimates. Alternative 2 also has a different cash flow between capital and operating costs.

Table 1. Sidestream Treatment Process BCE Total Net Present Value Summary[1,2]

Alternative	Description	Capital	Benefit	O&M	Risk	R&R	NPV
1	Centrate Precipitation w/ Harvest (Ostara)	$15,072,000	$2,692,000	$8,988,000	$297,000	$1,462,000	($24,661,000)
2	Direct Chemical Addition	$1,130,000	$0	$14,226,000	$2,815,000	$92,000	($20,259,000)
3	Centrate and WAS Precipitation w/ Harvest (Ostara)	$16,950,000	$5,083,000	$16,439,000	$427,000	$1,503,000	($32,441,000)
4	Digested Sludge Precipitation w/ Harvest (AirPrex)	$13,568,000	$422,000	$8,278,000	$564,000	$1,097,000	($24,724,000)
5	Digested Sludge Precipitation w/ Sequest (AirPrex)	$9,540,000	$0	$8,244,000	$137,000	$799,000	($20,154,000)

[1]Cells highlighted in green indicate the lowest cost alternative for the conditions shown (recycled water discharge beginning in 2026).

[2]Total costs are shown in 2018 dollars, represent the period 2021 through 2040, and are rounded to the nearest $1,000

NPV = net present value.

Sensitivities to this decision were tested to understand how the preferred alternative may change. This sensitivity analysis showed that Alternative 2 becomes favored over Alternative 5 under several conditions. If capital costs were to increase by only 2% the decision is changed. Alternative 2 also becomes the preferred alternative if O&M costs are 2% lower than those currently assumed.

Potential Consequences

The Design Review Committee should be aware of the potential consequences of each alternative that may not be readily apparent from the BCE results. The primary consequences from this evaluation are described in further detail below:

- **Capital vs. Operating Cost**: Alternatives 1, 3, 4, and 5 require the design and construction of a struvite reactor, which increases their associated capital costs. Conversely, Alternative 2 has limited capital costs but requires more significant on-going operational costs. Alternative 2 would increase the operational needs of the plant in terms of labor, maintenance, and chemical demands.
- **Increasing Chemical Costs:** Alternative 2 accounts for the risk of chemical costs increasing above the assumed inflation rate. Chemical costs are directly tied to commodity markets and it is possible that the cost of chemical associated with Alternative 2 (ferric chloride) will continue to increase beyond what is accounted for as a risk in the current BCE. This sensitivity was tested and showed that ferric cost increases favor Alternative 5 by an increasing margin. The cost of ferric has doubled in the last six years and if it continues to rise at the same rate, Alternatives 1 and 4 will also become preferred alternatives over Alternative 2.
- **Value of Recovered Product:** Alternatives 1, 3, and 4 all provide an opportunity to recover a product that could be marketed and sold. The value of this product varies between the options and the duration of a guaranteed price for the product can also vary. Alternatives 2 and 5 do not include product recovery, although this could be added to Alternative 5 in the future if desired. Based on the assumed value of the harvested product, Alternatives 1, 3, and 4 do not have a positive return on investment (i.e. the revenue does not cover the costs). However, the City may see additional value in recovering this product beyond the potential revenue.
- **Modification Potential:** Alternative 5 does not include equipment for harvesting a revenue-generating product, however, the base technology used is the same to that used in Alternative 4, which does produce a product. Alternative 5 maintains the possibility to install harvesting equipment in the future if the City decides to pursue product sale.

Recommendation

The preferred alternative of the BCE analysis was Alternative 5: Digested Sludge Precipitation, without Harvesting by a slim margin (0.5 percent of the total cost of asset ownership). While this alternative does not directly result in revenue it has lower associated operation and maintenance costs, risk costs, and capital costs than other alternatives. However, the analysis demonstrated that the decision is very sensitive to the cost assumptions with small changes changing the preferred alternative.

The Preliminary Design Technical Team recommends delaying the decision on the sidestream treatment technology so that more detailed cost information can be developed. Project Group B, constructed as part of the Phase I Upgrades and expected to be operational in Spring 2019, include a small ferric dosing system. Using the performance information and operating costs for this system will allow for more detailed estimates for Alternative 2. With this approach, the sidestream treatment facilities would be included as a separate contract package, which is discussed in DRC Briefing #18.