Biosolids Treatment & Disposal Strategy-Conserv II

Executive Summary

The City of Orlando continues to pursue a cost effective biosolids treatment and disposal strategy that lessens our dependency on land application. Land application is not a reliable disposal method since wet weather conditions can substantially impact our ability to spread stabilized biosolids on agricultural property.

The City has significant investment in the development of Super Critical Water Oxidation (SCWO) as a biosolids treatment technology. We remain hopeful that SCWO will be commercialized for biosolids treatment and it will be incorporated into the City's treatment approach in the future. Until that time, the City plans to run on two key parallel tracks as we progress into the future. These include:

- **Continue to partner with SuperWater Solutions in developing the SCWO technology.**
- **Upgrade the existing biosolids treatment and disposal strategy to provide a reliable approach that can meet the City's needs for the next 5 years or longer.**

The Anaerobic Digestion facilities at the Conserv II WRF are in need of a major upgrade. The age of the mechanical equipment has exceeded its useful life. The City had delayed upgrades to the digestion system under the assumption that future biosolids treatment would be accomplished using the SCWO technology. Since there is some uncertainty regarding the fate of SuperWater's development of the SCWO technology, a reliable biosolids approach is needed that can meet the City's needs over the short to mid-term (5-10 years).

Engineering consultants have estimated a range of $5 million to $14 million to restore the anaerobic digestion system. This range of expenditure would provide a 5 to 10 year solution that would permit the Conserv II WRF to produce Class B biosolids as it does today. Depending on the extent of the improvements to the anaerobic digesters, it could take up to three years to complete the project.

The Wastewater Division began investigating alternative treatment technologies that would potentially be quicker to implement, provide better treatment and incur less capital costs. The two processes that we considered were the Schwing Bioset Process and the Clean B Process by BCR Environmental. In each case, the biosolids are converted to a Class AA product. However, there are distinct differences on how the Class AA product is achieved.

The Bioset process will yield treated biosolids that meet EPA's Class A pathogen destruction criteria at the Conserv II Facility. The Clean B process is designed by BCR to achieve Class B standards. However, the process has not been approved by EPA yet. Therefore, a facility using Clean B would need to demonstrate the ability to meet Class B standards to FDEP. There is some risk associated with using technology that has not been recognized as acceptable by EPA.

The Clean B process offers cost advantages. Capital cost estimates for Clean B are $750,000 less than Bioset. As mentioned previously, the Bioset process provides a better level of treatment. The estimated

O&M costs for Clean B are about $63,000 less than Bioset. The net present worth values over a 10 year project life for Bioset and Clean B are $15.2 million and $13.9 million, respectively.

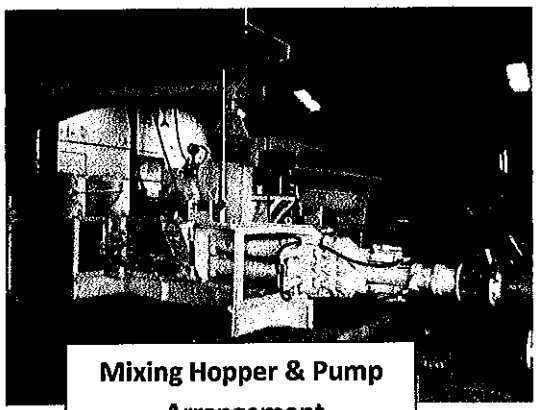
Based on staff's evaluation of these two processes, the Schwing Bioset process is the recommended approach.

The Schwing Bioset process offers several advantages:

- ✓ Bioset is a proven technology that is accepted by EPA and is a variation of a process that the City already uses at the Iron Bridge Regional WRF. There is minimal risk regarding regulatory acceptance.
- ✓ Bioset processing facilities are up and running and can immediately begin processing Conserv II biosolids.
- ✓ Bioset can produce a Class A product at the plant that can be converted to a commercial fertilizer.
- ✓ The Bioset Class A product could be land applied as a backup to the commercial fertilizer process.
- ✓ The Bioset approach substantially reduces if not eliminates the need for land spreading biosolids.
- ✓ The capital cost for implementation of the process is comparatively low.
- ✓ Under a design build approach, Bioset can be implemented in under 12 months.
- ✓ Operations & Maintenance (O&M) costs are competitive with the City's current approach to biosolids treatment and disposal. The City's annual O&M costs will be about the same producing a superior biosolids product.

The Schwing Bioset Process

The Schwing Bioset is a simple and reliable Class A biosolids solution that is accepted by FDEP and the USEPA. Class A biosolids have less disposal restrictions and when further processed into a commercial fertilizer, the material can be applied to virtually any turf surface or crop where nutrient enrichment is required. Personnel from the Wastewater Division visited operating facilities in the St. Petersburg and the Ft. Meade areas. The following is a brief description of the proprietary Bioset process:



Mixing Hopper & Pump Arrangement

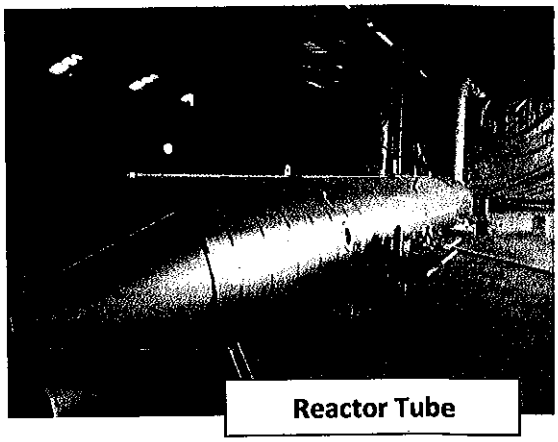
Sludge cake is conveyed into a hopper containing the Schwing twin auger mixer where it is mixed with powdered quick lime that is delivered using an enclosed metering screw. The Schwing piston pump then pulls the sludge/lime mixture from the mixing hopper to the Bioset reactor.

The sludge and lime mixture creates an exothermic reaction that can raise the sludge temperature to 70 degrees Celsius and raise the pH value as high as 12.4 (EPA requires pH to be greater than 12.0 for 2 hours

and above 11.5 for an additional 22 hours). Schwing Bioset has documented pH values greater than 12.0 six months after treatment. This fulfills the EPA Class A biosolids requirement for Vector Attraction Reduction.

The reactor temperature is maintained at no less than 55 degrees Celsius with a detention time of 40 minutes this fulfills the EPA Class A biosolids requirement for pathogen reduction. The force of the sludge pump pushes the mixture through the reactor and into the trailer. The material produced by Bioset is self leveling removing the need for shuttle conveyors to evenly distribute material in the trailers.

The gas from the reactor is captured and conveyed to an odor control scrubber. There were no detectable odors associated with the St. Petersburg facility. There was detectable odor at the Ft. Meade site. However, due to its remote location, odor control was not employed.



Reactor Tube

The Class A biosolids product could be delivered to Schwing Bioset's Class A receiving facility where it is further dried and delivered as a fertilizer to Schwing Bioset customers (according to Schwing Bioset, there is a backlog of customers wanting this product). This would reduce the City's vulnerability to closed disposal sites due to wet weather If for some reason, land application of biosolids is needed as a back-up to fertilizer processing, the Class A product produced by Bioset requires less land.

The estimated capital cost for the Schwing Bioset system is $2 million for the Conserv II WRF. This is significantly lower when compared to the cost range of $5 million to $14 million to rehabilitate the existing digesters which only achieves a Class B biosolids product.

The Water Conserv II WRF currently spends $1.65 million annually in operations and maintenance (O&M) costs to thicken, digest, dewater and transport Class B biosolids with City personnel and equipment to our current disposal sites. Implementation of the Bioset process would produce similar annual costs while creating a more desirable and a less restrictive product. Bioset has provided an estimate of $32/wet ton for hauling the Class A biosolids product to their facility for further processing into a commercial fertilizer. The estimated annual O&M cost for the Bioset process is $1,670,000.

BCR Environmental-Clean B

BCR Environmental (BCR) provides a proprietary chemical conditioning system for bioslids stabilization known as "Clean B". BCR is still seeking Class B approval from the Environmental Protection Agency (EPA) for Class B stabilization. Currently, each Clean B facility has to demonstrate the ability to achieve Class B stabilization standards through testing. The biosolids leaving the Conserv II WRF would be Class B

assuming confirmation through testing. City staff visited a facility in Clay County, Florida that was processing biosolids using the Clean B process.

BCR has proposed to transport the Class B stabilized biosolids to a future composting facility to be located in Haines City, Florida. The FDEP has granted a permit to construct the composting facility. BCR is projecting completion of construction in the first quarter of 2015. The City's biosolids would be co-composted with yard waste to yield a Class AA compost product that would be suitable for application on areas that are accessible to the public. The composting process represents further treatment

BCR originally had attributed significant volatile solids reduction to their process. In discussions with BCR, they corrected their assumption. Therefore, for the purposes of this evaluation, solids reductions due to chemical treatment are not being considered.

BCR estimates capital costs at $1,250,000. The estimated annual operations and maintenance cost for the Clean B system is $1,642,000

Cost Analysis

Four alternatives were analyzed including the following:

- Restore Anaerobic Digesters at $5 mil; continue land application of Class B material
- Restore Anaerobic Digesters at $14 mil; continue land application of Class B material
- Convert to Bioset and process Class A biosoids into commercial fertilizer.
- Convert to Clean B and process to Class AA biosolids by composting.

Table 1 presents a summary of capital, operations and maintenance (O&M), annual and present worth costs for each of the above alternatives. Based both on estimated annual and present worth costs, all the Bioset alternatives are less costly than the two alternatives that involve rehabilitation of the anerobic digesters. If the belt presses are able to reach a solids concentration of 18%, then the Bioset alternative is essentially equal to anerobic digestion from an O&M cost perspective. Recent testing of dewatering equipment on undigested biosolids at the Conserv II WRF suggests that 18% solids is achievable.

Conclusions

The proprietary process, known as Schwing Bioset, offers a superior biosolids product at a significant cost savings to the City's current mode of biosolids treatment and disposal. Based on the alternatives analysis, the estimated annual cost savings ranges from $369,500 to $1.535 million. The estimated present worth cost savings ranges from $2.85 million to $11.85 million. The Bioset process costs more than Clean B but it provides a higher level of treatment at the plant before transport for further processing. The Class A treatment provided by Bioset provides an improved biosolids product for land application if it is needed as a back-up to the fertilizer process.

The Bioset process is estimated to be more cost effective than continuing to treat biosolids at the Conserv II WRF using current treatment and disposal methods. Bioset's processing to a commercial fertilizer yields a product that provides the following benefits:

- Conversion to a commercial fertilizer product eliminates regulation of the product application by the FDEP.
- The Bioset solution is not impacted by wet weather. Class A treated biosolids may be hauled to Bioset's processing facility regardless of weather conditions. In addition, less area is required for land application of Class A biosolids if needed as a relief to the primary disposal method.
- Due to the reduced volume and weight achieved through fertilizer processing, less fuel is needed for transport and spreading of the finished product.

CONSERV II WATER RECLAMATION FACILITY

REVIEW OF BIOSOLIDS TREATMENT & DISPOSAL STRATEGY

B&V PROJECT NO. 180861

PREPARED FOR

City of Orlando, Florida

21 JANUARY 2015

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Executive Summary

The City of Orlando determined that previous approaches to biosolids management consisting of anaerobic digester improvements were cost prohibitive. Since early 2014, the City has considered alternative options to digester rehabilitation that consist of a design-build arrangement with an outside vendor. To support this strategy, the City's Wastewater Division developed a document (memorandum) titled Biosolids Treatment & Disposal Strategy – Conserv II. Black & Veatch has provided a Peer Review of the referenced document. Strategies considered included, 1) minimal rehabilitation of the existing anaerobic digesters, 2) design-build proposal by Schwing Bioset, and 3) design-build proposal by BCR Environmental.

The City concluded the Schwing Bioset was the most favorable option. Based on Black & Veatch's Peer Review, the selection of Schwing Bioset is a reasonable and cost effective solution. While the review did identify some cost assumptions which may merit modification, and some risks which should be considered going forward, the work did not identify any significant reasons to suggest that the City's planned adoption of the Bioset process is not a reasonable and cost effective solution to the goal of achieving a Class AA biosolids product with minimal capital cost investment at Conserv II.

1 Introduction

The City of Orlando (City) is currently considering options for upgrading existing sludge treatment facilities at the Conserv II Water Reclamation Facility (WRF).

The City is has received budget level quotations from two biosolids treatment vendors, Schwing (for their Bioset process) and BCR Environmental (for their Clean B™ process) and has conducted a life cycle evaluation in order to compare potential life cycle costs for the solutions being offered with the life cycle costs associated with refurbishing its existing digestion facilities.

Based on the outcome of the life cycle evaluation combined with a strong driver to move towards a Class AA product, the City is currently considering implementing the Schwing Bioset treatment system.

At the request of the City, this study has been conducted in order to review the current basis of evaluation put forward by the City and to make recommendations regarding the way forward with regard to potential solids treatment upgrades.

2 Aim & Objectives

The aims and objectives of this study are outlined below.

Aims:

- To review the City's basis for a proposed replacement of its digestion facility at Conserv II with the Schwing Bioset process to produce Class A biosolids
- To identify risks associated with the above solution and measures which can be taken to mitigate against those risks.

Objectives:

- Carry out a review of the quotations received from the two vendors.
- Review the life cycle cost evaluation put forward by the City and validate using further calculations if necessary.
- Identify risks associated with proceeding with the current proposed solution based on life cycle evaluation and market risks.
- Identify potential measures which could be considered to mitigate against these risks
- Identify alternative technologies which could be considered to ensure that the City is not missing any potential alternative solutions which could offer lower life cycle cost solutions.

3 Existing Process Background

The Conserv II WRF produces only waste activated sludge (WAS) from the liquid stream treatment process. The existing solids processes at the plant include mechanical thickening, conventional mesophilic anaerobic digestion, and dewatering. The WAS generated from the liquid process is

thickened using gravity belt thickeners (GBTs). The thickened WAS is pumped to one of two anaerobic digesters for stabilization. The digested solids are then transferred to a secondary storage tank, from which the solids are pumped to belt filter presses (BFPs) for dewatering. The dewatered solids are hauled offsite and land applied by a third-party contractor.

There are a total of four digester tanks, each with a capacity of 1.38 million gallons (MG). Only three of the four tanks are currently in use - two as primary digesters, operating in parallel, and one as a secondary storage tank. The primary digesters have fixed steel covers and the secondary storage tank has a floating gas holder cover. All the digesters are equipped with gas mixing systems. The existing digester covers, pumping, and mixing systems have exceeded their useful lives and are in need of replacement.

4 Review of Vendor Proposals

4.1 SCHWING BIOSET

4.1.1 Process Description

The Schwing Bioset process produces stabilized biosolids by treating sludge with lime and sulfamic acid in a plug flow reactor. The combination of alkaline conditions, high temperature (produced due to the exothermic reaction between the lime and the acid and by hydration of the lime) and high ammonia concentration serves to kill pathogens in the sludge in order to meet pathogen reduction requirements. Schwing is also able to supply a fluid bed dryer which can be used downstream of Bioset.

The Bioset process is summarized in Figure 1.

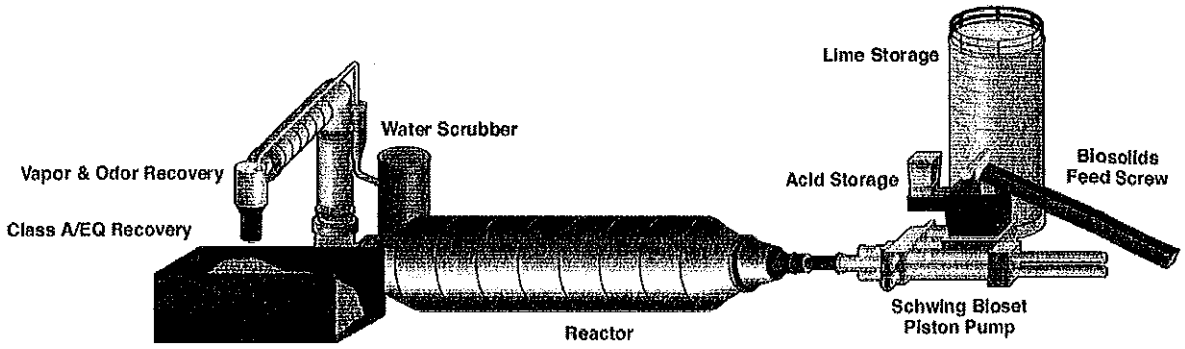

Figure 1 - Schwing Bioset Process (Courtesy Schwing Bioset)

4.1.2 Technology Status

The Schwing Bioset process is well established and has been installed at numerous locations across the USA including several in Florida. A summary of some key installations based on various case studies and other information from the vendor is provided in Table 1 below.

Table 1 – Bioset installations

PLANT	LOCATION	CAPACITY
City of Hollywood	Florida	48 MGD
City of St. Petersburg, South East Plant	Florida	20 MGD
City of St. Petersburg, South West Plant	Florida	20 MGD
South Bermuda	Florida	5000 lb/hr[1]
Glendale, Lakeland	Florida	-
City of Pahokee	Florida	-
Coleraine	Minnesota	0.5 MGD
City of Orlando	Ontario	40 MGD
Columbus	Nebraska	5 MGD
Dane/Iowa County	Wisconsin	0.75 MGD
Morgan City	Louisiana	4 MGD
Stewartstown	Pennsylvania	0.6 MGD
Kingwood	Texas	5 MGD
Minster	Ohio	-

[1]Bioset system solids capacity

The Bioset process is considered to be equivalent to a Process to Further Reduce Pathogens (PFRP) by the United States Environmental Protection Agency (USEPA) providing the following conditions are met:

- The Bioset process is to be used to treat municipal wastewater sludge with a total solids concentration between 6 and 35% by weight and with a minimum ammonium concentration in the reactor discharge of 0.5 mg ammonium/g dry weight.
- Dewatered sludge solids must be mechanically mixed with calcium oxide (quicklime) to achieve a pH of equal to or greater than 12 standard units.
- Sulfamic acid must be mixed with the sludge/quicklime mixture to maintain the temperature of the mix at equal to or greater than 55°C (131 °F).
- The process must be operated in a plug flow regime with a minimum operating pressure of 4 pounds per square inch and a minimum solids retention time of 40 minutes at a minimum temperature of 55°C (131 °F).

To achieve Class AA Biosolids, Chapter 62-640 of the Florida Administrative Code (F.A.C.) requires processes to meet the following requirements from Title 40 of the Code of Federal Regulations part 503.32 (a) and 503.33 (b)

- One of alternatives 1, 2, 3, 5 or 6 for pathogen reduction (under sections 3, 4, 5, 7 and 8 respectively) of part 503.32 (a).

- One of the options in parts 1 through 8 of part 503.33 (b) for vector attraction reduction.

The Bioset process is able to achieve the requirements for Class AA status in Florida by virtue of satisfying the requirements of Alternative 6 (for PFRP equivalency) and part 6 of 503.3 (b) for vector attraction reduction (raised pH). This is true provided that the pH of the treated biosolids remains above 12 for 2 hours and above 11.5 for another 22 hours after treatment.

4.1.3 Vendor Proposal

Schwing Bioset have provided a budget level quotation of $1.86 million (January 28, 2014) for provision of their Bioset system at Conserv II. The quote is for a single train of Bioset with no system redundancy. The quotation goes into a good level of detail for a budget quotation and includes the key items of equipment which would be required in order to divert dewatered cake from the existing dewatering belts, treat the cake in the Bioset process and discharge via piping to a truck load out.

As with any budget quotation, it is important to note that the quoted price is likely to change during contract negotiation and agreement of final scope. In B&V's experience, the final agreed price is almost always higher than that given in budget level quotations, due to additional scope being added during contract negotiation, and agreement of terms and conditions which increase the contractor's risk.

It should also be noted that there are requirements associated with housing the equipment and converting the existing digestion system which would be outside the current scope of supply. These include but will not be limited to:

- General detailed engineering associated with integration of new systems with existing systems which is not readily apparent at the time budget quotations are put together.

- Costs associated with decommissioning of the digestion system.

- Changes required to the City's treatment process in order to modify the existing dewatering process to treat waste activated sludge instead of digested sludge.

- System integration in order to link the local PLC (included) to SCADA

- Electrical connections in order to provide power to the local panel.

- Provision of housing or modifications to existing buildings necessary to house equipment which cannot be located outside.

- Other engineering / contract administration costs.

The above points are applicable to both the Schwing Bioset proposal and the BCR proposal and would therefore not be expected to significantly affect the relative ranking or comparison of these two processes.

In summary, the Bioset proposal is a good, budget level quotation but if the City decides to proceed with the process, it should be expected that actual costs associated with delivering the contract and making changes to the current system may come in higher than the figure quoted. At this stage, and without going into further detail it would be prudent to plan for up to a 50% increase in cost associated with the Bioset contract, plus additional costs associated with modifications and costs outside their contract scope.

The provision of a duty only system should be noted, since this would require an alternative route to be put in place for solids processing during maintenance periods (e.g. by diverting dewatered cake directly to landfill).

4.1.4 Biosolids Handling

A sister company of Schwing Bioset, Biosolids Distribution Services (BDS) can if required, provide operation of the Bioset Process including transportation and marketing of the treated biosolids. Operation of Bioset is relatively straightforward and should not, however, be an issue for the City's staff.

4.2 BCR CLEAN B

4.2.1 Process Description

BCR's Clean B process chemically treats biosolids using chlorine dioxide in order to reduce pathogen content and odor potential of the sludge. The process is summarized in Figure 2.

Figure 2 – Summary of BCR's Clean B Process

Sludge is delivered to the process at 2% solids or above. Chlorine dioxide is generated on site and applied at a controlled rate in order to achieve partial disinfection of the sludge. Sludge flows through a plug flow disinfection vessel to provide reaction time with the applied chemicals and is then passed forward to dewatering.

As well as the Clean B™ process, BCR are also able to offer their Neutralizer® process which is recognized by the USEPA as equivalent to a PFRP and has several installations in Florida. Since the company has recommended Clean B™ for this application and has not proposed Neutralizer®, Neutralizer® is not considered further in this evaluation except in the context that the initial chlorine dioxide disinfection stage of the Neutralizer® process is the same as Clean B™ and is therefore relevant in terms of providing additional demonstrated operating experience with the technology.

4.2.2 Technology Status

BCR's Clean B™ and Neutralizer® processes have recently become well established in Florida with 11 sites in operation and 4 currently under development. Details are provided in Table 2 below.

Table 2 - BCR installations

PLANT	TECHNOLOGY	INSTALLED	CAPACITY
City of Alachua	Clean B™	2010	4 MGD
Naval Air Station, Jacksonville	Clean B™	2012	-
Fort Pierce Utility Authority	Clean B™	2013	8 MGD
Haines City	Neutralizer®	2012	3 MGD
Martin County (2 plants)	Neutralizer®	2013	5.9 + 2.8 MGD
Clay County (4 plants)	Neutralizer®	2006 – 2010	2 to 5 MGD each
City of Starke	Neutralizer®	2009	Capacity

To achieve Class B Biosolids, Chapter 62-640 of the Florida Administrative Code (F.A.C.) requires processes to meet the following requirements from Title 40 of the Code of Federal Regulations part 503.32 (b) and 503.33 (b).

- One of alternatives 1, 2 or 3 (under sections 2, 3 and 4 respectively) for pathogen reduction under part 503.32 (b)
- One of the options in parts 1 through 10 of part 503.33 (b) for vector attraction reduction.

The route for achieving Class B disposal in the State of Florida for the Clean B™ biosolids would be via alternative 1 for pathogen reduction and part 10 of 503.33 (b) for vector attraction reduction. This has the following implications.

- In order to satisfy alternative 1 for pathogen reduction, the treated biosolids would need to be tested to demonstrate mean fecal coliform levels of less than 2 x 10^6 per g total solids from 7 samples.
- In order to satisfy part 10 for vector attraction reduction, the biosolids would need to be incorporated into soil within 6 hours of application. This requirement creates a difficult constraint on the biosolids applicator and is a disadvantage to the Clean B process.

Alternatively, the biosolids from the Clean B™ process could be further processed off site by BCR or another contractor to achieve a higher quality product.

The pathogen reduction requirement is not too much of a concern (other than the requirement for sampling and analysis) since it should be possible to increase the chlorine dioxide dose rate until the pathogen standard is met (although obviously the dose rate needed has implications regarding operational cost).

The restrictions on disposal flexibility requiring incorporation within 6 hours of application should be noted. If the biosolids are being hauled and land applied by BCR then meeting the requirements for vector attraction reduction is their responsibility. However if for any reason the disposal contract needed to be revoked (e.g. if BCR went out of business) then the City would need to take on the responsibility for disposal or find an alternative contractor. The restrictions on disposal flexibility would obviously limit options in this regard.

4.2.3 Vendor Proposal

BCR presented the City with budgetary equipment and project cost estimates for their Clean B™ system with and without pre-thickening. With pre-thickening reducing the size of the Clean B™ facility required (and associated costs) the vendor recommends installation of Clean B™ with pre-thickening, followed by dewatering. The budget cost estimate given for the Clean B™ equipment with pre-thickening is $1.5m and the estimated project cost is $2.45m.

The presentation does not provide any detail of what is included in the budget level scope and the cost estimate should therefore be taken only as a preliminary indication of potential cost of providing the BCR Clean B™ solution. As with the Bioset discussion above, there are also likely to be significant add-on costs which are outside the scope of what BCR have currently included in their estimates.

4.2.4 Biosolids Handling

BCR provides hauling operations with several disposal routes available including Class B land application and a composting facility for further processing in Haines City.

5 Life Cycle Costs

Based on the budget estimates provided by Schwing and BCR, the City put together life cycle cost estimates to compare life cycle costs for the following options.

- Refurbishing and maintaining the existing digestion, based on an initial capital cost of $5m.
- Refurbishing and maintaining the existing digestion, based on an initial capital cost of $14m.
- Converting to the Schwing Bioset process.
- Converting to the BCR Clean B™ process.

A summary of the City's life cycle cost estimates is provided in Table 3.

Table 3 - Summary of life cycle costs estimated by the City

COST	RESTORE ANAEROBIC DIGESTION $5M	RESTORE ANAEROBIC DIGESTION $14M	CONVERT TO BIOSET (ASSUMING 16% CAKE)	CONVERT TO BCR
Capital Cost	$5m	$14m	$2m	$1.25
Annual Operating Cost	$1.65	$1.65	$1.74	$1.64
Net present value[1]	$17.7	$26.7	$16.45	$13.9

[1] Net present value was calculated at 5% discount over 10 years.

In order to review and validate the life cycle cost estimate conducted by the City, B&V initially replicated the City's calculation using the same assumptions. This resulted in net present value estimates of $18m, $16.6m and $14m for restoring the digesters (at a capital cost of $5m), converting to Bioset and converting to BCR respectively. These figures are very similar to the values estimated by the City.

On review of the assumptions made in the life cycle cost estimate, several items were noted which may merit further consideration for review and possible modification in the evaluation. While it is likely that, on review, the City will confirm that some of these items do require modification and some do not, it was felt that providing a revised life cycle cost estimate with the modifications carried out would be useful to the City in order to determine what the potential impact of these changes would be. The items identified from the City's evaluation and modifications made in the revised evaluation are summarized as follows:

- The City's evaluation assumed that no belt filter press odor fans run if the Bioset solution is used. While WAS dewatering will undoubtedly produce less odor than digested sludge, it is standard practice to install odor control for new belt press operations processing WAS. The revised evaluation included power for the belt filter press building odor fans for all options.

- Volatile solids reduction (VSR) was initially assumed to be 38 percent. Based on input from the City regarding current performance this was modified to 54%, giving 6.8 dry tons per day (dtpd) digested sludge solids (based on an assumed volatile solids content of 80% in the WAS feed).

- It appeared that power usage in the original evaluation was based on 24 hour per day, 7 day per week operation for all drives. Also, some of the calculations did not convert horsepower (HP) to kilowatt hours (kWh) before multiplying by hours run to get kWh per day. For the revised evaluation, hours run were estimated based on throughput requirements and equipment capacity, and power consumption in kWh per day was calculated based on the drive sizes supplied by the City and the vendors. (i.e. to account for the fact that either the equipment may not run for 24 hours per day, or that if it is operating 24 hours per day but below its maximum capacity then power draw would be less than the power draw at maximum throughput)

- Power consumption for the digesters was assumed to be 145 HP. Without further detail regarding the breakdown of this value, it was not clear as to how it should be applied with respect to hours run and actual power draw. For the revised evaluation, a typical power consumption of 15W/m^3 digester volume was used and applied to the combined volume of two digesters.

- Labor for the Bioset process was assumed to be included in the belt filter press operation. Bioset will require some labor and it did not appear that any of the labor associated with the digestion option was assumed to be absorbed in the BFP operation. The revised evaluation was based on 2 hours per day operator time for Bioset operation.

- Maintenance for the Bioset system was assumed to be $2.5k per year. The Bioset quote states $6k per year for wear parts alone. This does not include unplanned maintenance or

labor. The revised evaluation was based on a standard allowance of 2 percent of equipment cost. Equipment cost was assumed to be 50 percent of the cost of the turnkey budget quote. This resulted in an allowance of $18.6 k per year.

- Aeration power for treatment of digested sludge dewatering filtrate was assumed to be 350HP. For the revised evaluation, filtrate return loads were estimated based on 1000mg/l NH3-N and 1000 mg/l soluble BOD in the digester. The required actual oxygen requirement (AOR) was calculated based on 4.3lb O_2 per lb NH3-N (assuming no denitrification recovery) and 1 lb O_2 per lb BOD. The required standard oxygen requirement (SOR) was calculated assuming AOR/SOR = 0.5 (which is typical). The aeration power requirement was calculated assuming a typical oxygen efficiency of 2.5 kg O2/kWh. The resulting power draw used was calculated as 59HP.

- No costs for sulfamic acid were included. Costs were included in the revised evaluation however this resulted in a negligible cost increase (for the Bioset option).

- The capital cost for the BCR Clean B™ process used in the City's evaluation was $1.75 million. The quote from BCR states $2.45 million. Discussion with the City suggests that BCR originally quoted a redundant system and the reduction to $1.75m was made in order to provide an in-kind comparison with Bioset (who quoted a system without redundancy). A value of $1.75m was retained in the revised evaluation. Since the BCR process precedes dewatering it would be necessary to include a bypass around the BCR process to the dewatering belts in order to allow for maintenance on the system.

- Based on previous work evaluating the potential cost of digester upgrades at Conserv II, it was felt that a cost of $5 million is overly optimistic, while the cost of $14 million could be cut significantly if the City opted not to refurbish all the digesters. In order to provide a reasonable benchmark against which to compare the Bioset and BCR solutions, a life cycle cost estimate based on a $7.5 million upgrade was included in the revised evaluation for reference (as well as an estimate based on a $5 million upgrade which was retained for reference).

A summary of the life cycle costs is provided in Figure 3, which includes the replicated calculation of the City's estimates, plus revised estimates based on the discussion items noted above. In line with the City's own estimates, life cycle costs were all calculated over 10 years at a discount rate of 5 percent.

Note that to allow for the impact of cake solids content on the life cycle cost to be evaluated for the proposed Bioset solution, costs were provided at 14% and 18% dry solids in line with the City's evaluation. Expected performance would be somewhere within this range.

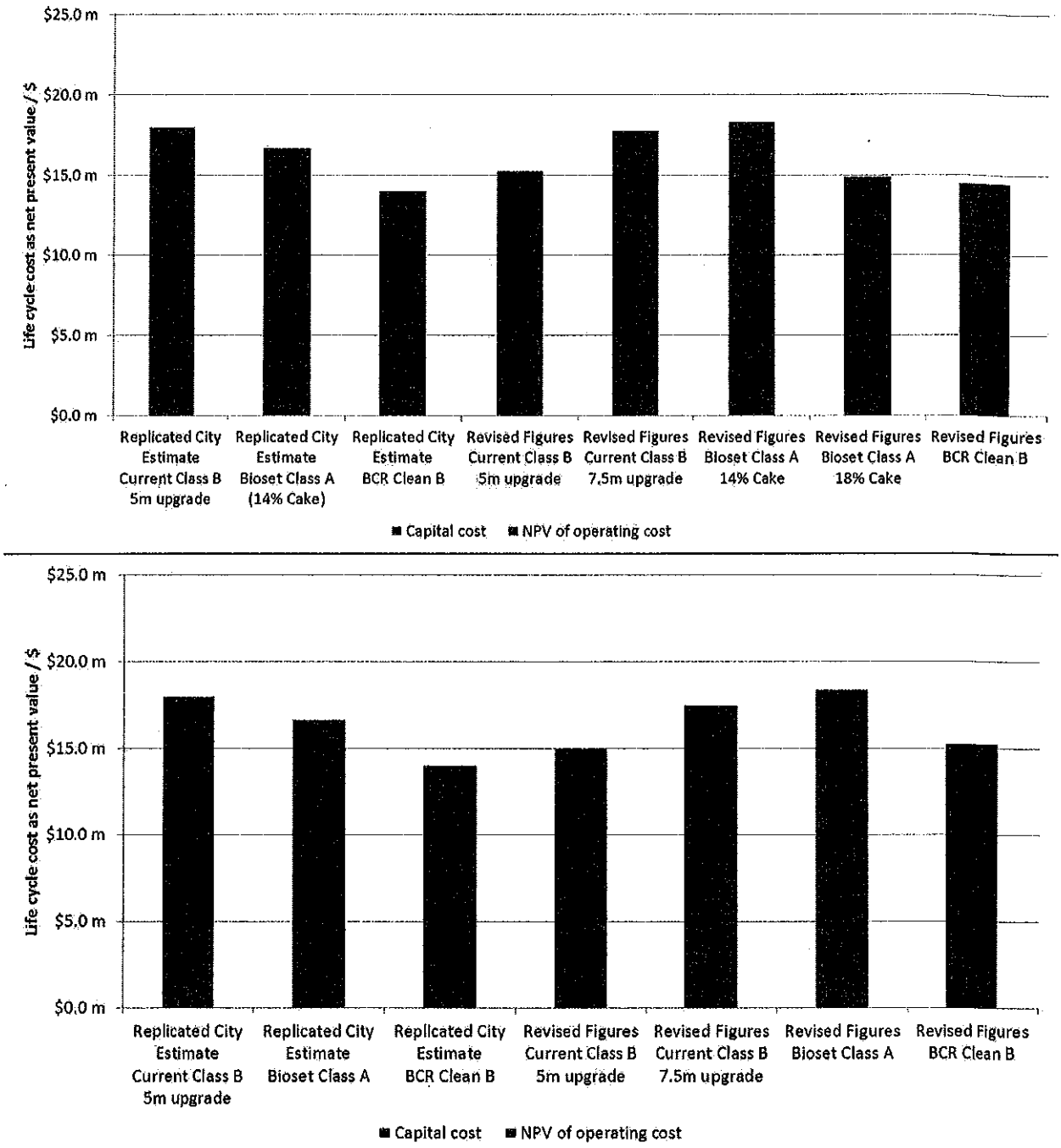

Figure 3 - Life cycle costs estimates

The following points are worth noting in relation to Figure 3 above.

- The costs for BCR are largely based on the supplier's values with minimal validation (due to there not being much detail in the presentation budget values). The City desires the end product to be Class A. Even though the BCR Clean B™ indicates a similar life cycle cost to Bioset, the similar life cycle costs for the two processes do not appear to justify acceptance of a lesser quality, Class B, product. Therefore, no further effort was put into further validating the basis for BCR's values.

Table 4 - Change in risk profile associated with adopting Bioset compared to maintaining existing process

RISK ITEM	COMMENTS ON RISK	MITIGATION / GENERAL COMMENTS
Solids disposal / marketability	As noted above, Bioset offers contract disposal services. In the event that the disposal contract needs to be revoked (e.g. due to a company going out of business) the City would be reliant on either instating another disposal contract with another firm, or commencing its own disposal operations. Bioset produces a Class AA product which has greater marketability than the current Class B product in the event of contract revocation. The Class AA product also reduces exposure to potential increases in the cost of Class B disposal if more facilities move towards Class AA biosolids in future.	Negotiate a long term fixed price or index linked contract for biosolids disposal. It would be advisable to have a contingency plan in place for reverting to an alternative disposal contractor or instating the City's own disposal operations in the event of a problem with the disposal contract. Orlando has a relatively stable market for Class AA biosolids re-use for land application. It should however be noted that alkaline stabilized Class AA biosolids may not necessarily have the same market value as nonalkaline stabilized Class AA biosolids. Disposal to landfill is an option as a temporary last resort.
Process risk – redundancy	The Bioset process proposed only includes a single process train.	Put in place a sludge management strategy to allow for maintenance of Bioset system (planned and unplanned). This could involve: • Buffering of initial solids production using on site storage (e.g. using the old digesters) • Provision of an emergency disposal route for sending dewatered cake to landfill • Provision of a standby train
Process risk – WAS dewatering	With the Bioset process and no pre-thickening, unthickened WAS would need to be processed directly by the dewatering belts. This would result in a significant increase in the hydraulic loading on the belts (around 8 times current hydraulic load).	The City has confirmed that there is adequate belt capacity to process the required WAS flow and load and that operating times can be increased to meet the demand. The City is currently carrying out design improvements to the dewatering process.

8 Conclusions

The following conclusions were reached having conducted this evaluation.

- While the Bioset quotation is of a good standard for a budget level quotation, a higher price may be expected if the project moves towards a more contractual bid.
- The proposed Bioset solution offers no process redundancy.
- The BCR estimates are preliminary and additional detail would be required if the City wishes to consider this option further.
- The Bioset solution provides a Class AA product at a similar, if not slightly less, life cycle cost as compared to upgrading the existing (Class B) digestion facility.
- In general, the Bioset process offers the City a reasonable and cost effective solution to the City's biosolids treatment goal of achieving a Class AA product with minimal capital cost investment.

9 Recommendations

The following recommendations are made:

- If the City is interested in progressing with an alkaline stabilization type process, it would be advisable to put a specification together in order to request firmer quotations from potential suppliers in order to ensure that all of the required scope of the project is being captured, before taking a decision to proceed with a particular vendor.
- Consider the risk associated with lack of redundancy for a single train biosolids treatment solution and how maintenance would be managed on site and biosolids disposal would be achieved during this period.
- If the City is interested in further evaluation of the BCR process, then a more detailed quotation should be requested from the supplier.
- Consider negotiating long term biosolids disposal and chemical purchase contracts with either a fixed price, or index linked pricing to minimize the risk of exposure to potential price escalation.
- It would be worth carrying out a detailed evaluation of the dewatering belts and associated systems to verify equipment operating requirements and capability processing unthickened WAS, including requirements for hours run and system redundancy.

APPENDIX A – LIFE CYCLE COST CALCULATIONS

City would minimally have to make to continue the present course of producing and disposing of Class B biosolids. City staff estimated a present worth cost over 10 years of $17.7 million for this option. Using Schwing Bioset, the estimated present worth was estimated at $14.9 million. In addition to being more cost effective, the Schwing Bioset approach provides the following benefits:

- Produces Class A biosolids at the WRF with potential post treatment to a Class AA product or a commercial fertilizer
- Potentially eliminates reliance on land application
- The process can be implemented relatively quickly (approximately 12 months)

The City engaged the engineering firm of Black and Veatch (B&V) to conduct a peer review of the Division's evaluation and they published a report titled "Conserv II Water Reclamation Facility Review of Biosolids Treatment and Disposal Strategy " dated January 21, 2015. B&V refined the cost estimates but they did not detect any major flaws in the Division's analysis. Their estimated present worth cost for maintaining Class B treatment was $17.8 million and their estimated present worth cost for Bioset ranged from $14.4 million to $18.3 million depending on the quality of the biosolids that are being fed into the process. Based on the Division's experience we expect that the lower end of the cost range will be achievable.

The B&V report has not changed the Division's conclusions regarding the biosolids strategy that we wish to implement at the Conserv II WRF. The proprietary system offered by Schwing Bioset will accomplish the following:

- At a lower cost, the Division will be able to upgrade treatment from Class B to Class A
- When coupled with post treatment conditioning, the Class A biosolids can be transformed to a commercial fertilizer totally eliminating the Division's reliance on land application
- Capital costs are low
- The process can be implemented quickly to restore biosolids treatment reliability to the facility

The Division is requesting your approval for procurement of the Bioset process and equipment from Schwing Bioset. For your information, the studies that were conducted by the Division and by Black & Veatch are attached. Please let me know if you require any additional information.

C: Richard M. Howard, PE, Director of Public Works
Paul Deuel, Assistant Wastewater Division Manager
Kristie Fries, PE, Project Manager