APPENDIX 6

‘Expert Panel’ Meeting Materials and Summary Notes
1. INTRODUCTION

Phases 3 and 4 of the Class Environmental process have been initiated to identify a preferred design concept for expansion of the Woodward Avenue WWTP, and upgrading of the treatment process with a goal to ultimately achieve performance targets established in the City’s Water and Wastewater Master Plan. To achieve these targets, the upgraded and expanded plant will provide year round nitrification and tertiary phosphorus removal.

A workshop of wastewater process experts was undertaken to develop and screen a long list of potential design concepts for secondary and tertiary treatment for the expanded plant, and to identify a short list of the best concepts for further development and evaluation. This document provides an overview of the workshop.

2. PRESENTATIONS

Deborah Ross – Workshop Objectives

Goals of workshop:

- Create a long list of potential technological concepts to upgrade the Woodward Ave WWTP
- Using a must meet criteria, condense list to feasible concepts
- Via a double weighted matrix, condense list to 3 or 4 potential technologies that will endure a more thorough conceptual design.

City of Hamilton – Background & Drivers to Woodward Ave WWTP

- Wet weather flow is a big issue in Hamilton, thus CSO’s must be managed and inter-related with the WWTP. Recently, the wet well has reached dangerous levels with all 8 pumps running (flow over 1,600 MLD)
- Hamilton has a number of areas that are important for preservation, such as Coutes and the beaches. Sensitivity must be taken into account protect these areas by limiting toxins entering these areas through CSO overflows into these zones
- Hamilton is a big industrial town that accounts for approximately 50% of the loadings into Woodward WWTP
- In 2005, flows to the Woodward Avenue WWTP were approaching 94% of the total capacity
- Three driving forces:
  - Increasing dry weather flow
  - Effluent quality improvements
    - RAP – Remedial Action Plan
    - MOE – F-5-5
    - Targets to be achieved by 2015
- Treatment of wet weather flows

- Past/on-going projects
  - Optimization studies including hydraulic restrictions
  - Scoping study
  - MBR pilot study for tertiary treatment
  - Completed upgrades to dewatering (centrifuges), digester upgrades, cogeneration, standby power, etc.
  - Primary clarifiers are currently being upgraded
  - Biosolids Master Plan

Tim Constantine – Overview of WWTP Design & Performance

- Woodward Ave WWTP is currently rated for 409 MLD capacity average day flow and 614 MLD peak

- Effluent limits (based on monthly average)
  - cBOD₅ = 25 mg/L (10,225 kg/day)
  - TSS = 25 mg/L (10,225 kg/day)
  - TP = 0.8 mg/L (327 kg/day)

- Operating objectives (based on monthly average)
  - cBOD₅ = 15 mg/L (6,135 kg/day)
  - TSS = 25 mg/L (6,135 kg/day)
  - TP = 0.8 mg/L (327 kg/day)
  - E. coli (organisms/100 mL) May 15th to October 15th - < 200

- Scoping study
  - There is sufficient site space with conventional technology and best available technology (i.e., membrane technology)

- Visual description of plant processes on aerial map as well as overview of rated capacity for each process

- Plant problems
  - Difficult to control 2/3 of flow to North Plant
  - Chlorine contact chamber is limited on size.
  - Primary clarifiers have capacity of 1,254 MLD (1,100 ML/d if assume on clarifier out of service), hydraulically limited to 670 MLD
  - Oxygen transfer is difficult in aeration basins due to tapered floor
Deborah Ross – Constraints, RAP, MOE, & Community Concerns

- Goal is to reduce discharge of CSO into Hamilton Harbour. Two targets:
  - RAP loading targets (kg/d)
    - Phosphorus – 140 initial (60 final)
    - Ammonia – 2,270 initial (530 final)
    - Suspended Solids – 3.750 initial (900 final)

- MOE Policy F-5-5
  - No dry weather overflows
  - Maximize secondary treatment capacity
  - Capture 90% (per year) of wet weather flow and achieve primary treatment
  - Beach control

- Design objectives
  - Provide tertiary treatment for 1,000 MLD (peak hr) sustained for 6 hours, 820 MLD (peak day) sustained continuously, 500 MLD (annual average)
  - Year round nitrification
  - Upgrade primary treatment capacity to 1,300 MLD
  - TSS = 3 mg/L
  - TP = 0.15 mg/L
  - NH₃ = 5 mg/L (designed for coldest winter month, therefore average monthly concentration will be 1-2 mg/L)

- Important considerations
  - Sustained peak flows
  - Eliminate CSO tank overflows to the harbour when plant capacity is available
  - Community considerations (i.e. odour, noise, etc)
  - Schedule
  - Potential for phase in level of treatment
  - Potential to phase in capacity
  - Plant (site capacity, reserves)
  - Triple bottom line

City of Hamilton – Availability at Site

- New administration building in SW corner to free up existing admin building for treatment area
NE corner available (rail-car and globe can be relocated)

★ Land available east of clarifiers equalling one clarifier length

★ NW corner (north of wet well) available (watermain can be relocated)

★ Resistance from community to build south of plant, but can use if last resort

★ Depending on solids treatment (incineration, digestion, or both) the current digesters & dewatering area may have site availability

**Issues Discussed During Presentations**

★ Flexibility in design plan is very important
  - What should happen if Hamilton residents shift from blue-collar to non blue-collar? Potential for more stringent effluent demands.
  - What should happen if new industries appear in Hamilton, i.e. pharmaceuticals, or if steel industries vacate Hamilton? How does this effect loading to the WWTP or revenues for the City?
  - Phasing is very important to ensure that the City is investing as community needs it, and building in short term measurable, controllable segments. Modular design will be essential
  - Many environmental and social aspects that have to be taken into consideration

★ Other options to mitigate load to plant
  - Treating industrial waste before it enters Woodward WWTP.
  - Redesign CSO tanks and flows

★ Loading
  - BOD is 3-4 times higher and TSS is 2-3 times higher than normal residential flows
  - How much loading from industrial, residential, recycles?
  - Centrate is the main ammonia loading at the plant

★ Phasing in with respect to dry and wet weather flow
  - Wet weather flow adds negligible load
  - Need to design hydraulically for peak hour flow (i.e. for clarifiers and filtration), and then phase in biological treatment (i.e. aeration) capacity to follow trends for population increase
  - This will allow both RAP and MOE targets to be met
3. **WORKSHOP**

3.1 **CURRENT CONSTRAINTS AND DEFICIENCIES AT WOODWARD WWTP**

- Raw wastewater PS wet well is too small
- Flow measurement
- Disinfection
- Hydraulic distribution between treatment trains/plants and various tanks
- Hydraulic configuration of aeration tanks (south plant in part)
- North plant secondary clarifiers – shallow hydraulics (square)
- SVI, settling, solids management constrain ability to treat sustained peak flow in secondary treatment
- Outfall capacity around 1,100 MLD; will secondary plant be flooded
- Existing CAS is 300 MLD for nitrification
- RAS pumping capacity
- RAS distribution (south plant in particular) & control between aeration tanks
- Air balancing between cells and tanks in aeration tanks
- Aeration gates need replacement and automation
- Secondary clarifier gates and collector mechanisms
- Structural assessment of North tankage
- Blower building plus system upgrade
- Step feed
- WAS flow measurement

3.2 **LONG LIST OF POTENTIAL TECHNOLOGIES**

- CAS + tertiary MBR
- CAS – 2 stage nitrification + filtration
- Conventional MBR
- Single stage nitrification with filtration
- CAS + tertiary BAF + filters
- IFAS + filters
- CAS + MBBR + filtration
- CAS + IFAS + filtration
CAS + RBCs + filtration
CAS + nitrification TF + filtration
Wetlands
Replacing existing CAS with new (single stage nitrification) + filtration
Existing (derated) CAS + filtration (derated) + parallel MBR
Bioaugmentation (side stream) + CAS + filtration
Bioaugmentation (parallel plant) + CAS + filtration
BNR + filtration
Any High rate tertiary clarification
Expand capacity with parallel SBR
Expand with parallel oxidation ditch
*Animox, Sharon – sidestream treatment
High purity oxygen AS + filtration
CAS + tertiary membrane
CAS + HPO nitrification + filtration
MBBR + filtration
*Stacked secondary clarifiers
*Modifications of existing aeration tanks for series
BAF in parallel with CAS
MBBR + DAF + filtration
TF/AS as parallel train
*Break point chlorination
*Ion exchange
IFAS as parallel train
*Industrial Source control – decrease load on WWTP

* not complete technologies for expansion, but may be used in combination with other concepts

Legend
Filtration may be with sand or cloth
CAS = Conventional Activated Sludge
3.3 EVALUATION OF LONG LIST

1. Existing Plant Options
   - CAS (no nitrification) rated for 300 MLD
   - CAS (with nitrification) existing
   - CAS (no nitrification)
   - Replace in existing area (with nitrification)
   - Stress existing plant or by-pass

2. Must meet Criteria
   - Maintains plant operation during construction
   - Fits within site boundaries
   - Meets performance objectives for TSS, NH₃, and TP
   - Technology has been demonstrated or is being developed for similar plant size and climate

Long list of potential treatment options evaluated in

Table 1 as a group
<table>
<thead>
<tr>
<th>Treatment Options</th>
<th>Existing Plant Option that Applies</th>
<th>Failed a Must Meet Criteria</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 CAS + Tertiary MBR</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 CAS - 2 stage nitrification + filtration</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Conventional MBR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Single stage nitrification with filtration</td>
<td>b,d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 CAS + tertiary BAF + filters</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 IFAS + filters</td>
<td>b,d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 CAS + MBBR + filtration</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 CAS + IFAS + filtration</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 CAS + RBCs + filtration</td>
<td>F(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 CAS + nitrification TF + filtration</td>
<td>c</td>
<td>F(4)</td>
<td></td>
</tr>
<tr>
<td>11 Wetlands</td>
<td>F(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Replacing existing CAS with new (single stage nitrification) + filtration</td>
<td>F(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Existing (derated) CAS + filtration (derated) + parallel MBR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Bioaugmentation (side stream) + CAS + filtration</td>
<td>b,d</td>
<td></td>
<td>Keep as a design option but will not analyze</td>
</tr>
<tr>
<td>15 Bioaugmentation (parallel plant) + CAS + filtration</td>
<td></td>
<td></td>
<td>see above</td>
</tr>
<tr>
<td>16 BNR + filtration</td>
<td>d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Any high rate tertiary clarification</td>
<td>F(3)</td>
<td></td>
<td>Potential for future upgrade</td>
</tr>
<tr>
<td>18 Expand capacity with parallel SBR</td>
<td>F(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Expand with parallel oxidation ditch</td>
<td>F(2,4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Animox, Sharon - sidestream treatment</td>
<td></td>
<td></td>
<td>Design suggestion</td>
</tr>
<tr>
<td>21 High purity oxygen AS + filtration</td>
<td>F(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 CAS + tertiary membrane</td>
<td></td>
<td></td>
<td>Same as #4</td>
</tr>
<tr>
<td>23 CAS + HPO Nitrification + filtration</td>
<td>a,c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 MBBR + filtration</td>
<td>b,d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Stacked secondary clarifiers</td>
<td></td>
<td></td>
<td>Will be considered with rebuild options</td>
</tr>
<tr>
<td>Treatment Options</td>
<td>Existing Plant Option that Applies</td>
<td>Failed a Must Meet Criteria</td>
<td>Comments</td>
</tr>
<tr>
<td>-------------------</td>
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<td>-----------------------------</td>
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</tr>
<tr>
<td>26</td>
<td>Modifications of existing aeration tanks for series</td>
<td></td>
<td>Design suggestion</td>
</tr>
<tr>
<td>27</td>
<td>BAF in parallel with CAS</td>
<td></td>
<td>Combine with #5</td>
</tr>
<tr>
<td>28</td>
<td>MBBR + DAF + filtration</td>
<td></td>
<td>Combine with #24</td>
</tr>
<tr>
<td>29</td>
<td>TF/AS as parallel train</td>
<td>F(4)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Break point chlorination</td>
<td>F(4)</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Ion exchange</td>
<td>F(4)</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>IFAS as parallel train</td>
<td></td>
<td>Combine with #6</td>
</tr>
<tr>
<td>33</td>
<td>Industrial source control</td>
<td></td>
<td>Not a treatment upgrade at the WWTP</td>
</tr>
</tbody>
</table>

3.4 CONDENSING LIST OF FEASIBLE CONCEPTS

**Design Criteria**

1. Primaries
   - Conventional: BOD 35%, TSS 50%
   - CEPT: BOD 50%, TSS 70%

2. Aeration
   - Single stage: SRT 12 days, yield 0.8 kgTSS/kgBOD
   - Two stage
     - Stage 1: SRT 3 days, yield 1 kg TSS/kg BOD
     - Stage 2: SRT 12 days, yield 25 mg/L
   - BAF nitrification: 20 m$^3$/m$^2$/hr (peak day)
   - BAF no nitrification: 10 m$^3$/m$^2$/hr (peak day)
   - Volumetric oxygen transfer: 100 mg/L O$_2$/hr (average day flow)
   - O$_2$ requirement

3. Secondary Clarifiers
   - SOR (m$^3$/m$^2$/d): 40 (existing), 49 (new)
   - SLR: 175 kg/m$^2$·d for peak hour assuming 100% recycle at average day flow
   - Max MLSS: < 3,500 mg/L

4. Capacity of existing plant: see
5. Table 2

Table 2: Capacity of Existing Plant

<table>
<thead>
<tr>
<th></th>
<th>Solids Retention Time (d)</th>
<th>Conventional</th>
<th>CEPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing North and South Plants</td>
<td>3 day</td>
<td>310</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>12 day</td>
<td>260</td>
<td>300</td>
</tr>
<tr>
<td>Rebuild Existing Capacity on Existing Footprint</td>
<td>3 day</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>12 day</td>
<td>410</td>
<td>470</td>
</tr>
</tbody>
</table>

3.5 COMPLETION OF MINI-WORKBOOKS

Expert Panel completed mini-workbooks to analyze the various treatment options that passed the "must meet criteria" from Table 1.

3.6 CONSOLIDATED LIST OF FEASIBLE TECHNOLOGY OPTIONS

- **IFAS**
  - Construct 2 new IFAS trains
  - Sequentially replace existing plant with new IFAS tanks
  - Involves rebuilding the entire existing plant

- **CAS + IFAS**
  - Retain 260 MLD in existing CAS
  - Construct IFAS for 240 MLD

- **Two-Stage Nitrification**
  - Baseload existing CAS at 409/614 MLD (average day/peak) & size second stage for secondary effluent plus 91 MLD primary effluent. Add effluent filtration. Can also rebuild existing plant to 500 MLD, but possibly more expensive
  - CEPT, put 409/614 MLD through existing CAS, two-stage nitrification in NE part of plant, then tertiary filtration

- **BPR (Biological Phosphorus Removal)**
  - Feasibility for options with new tanks or significant rebuild to existing tanks

- **MBBR**
  - Treat 260 MLD in existing plant and treat 240 MLD in parallel MBBR (with clarifiers) located in North area, plus tertiary filters
BAF
- Same as #5 but with BAF instead of MBBR

Tertiary MBBR
- Treat average flow in existing plant (500 MLD), then bypass peaks and treat SE peak in tertiary MBBR. May include CEPT during peaks
- Saves from building clarifiers

Tertiary BAFs
- Same as #7 but with tertiary BAFs

CNAS (Conventional Nitrifying Activated Sludge)
- Treat 300 MLD in existing plant with CEPT (winter), plus add 200 MLD CNAS plant in parallel (taking up NE area)

MBR
- Build 5 + 1 train MBR (60m x 120 m) in NE area
  10a. Suitable for TNMBR (Tertiary Nitrifying MBR) OR
  10b. Parallel capacity

3.7 EVALUATING TECHNOLOGY CONCEPTS THROUGH DOUBLE WEIGHTED CRITERIA MATRIX

Evaluation Criteria
- With aid from City team members, created evaluation criteria and weights/ranks (2 different methodologies for comparing options) (see being the most important)
- Table 3)
- Weightings: 1 – 5 (5 being very important)
- Ranking: from 1 – 9 (9 being the most important)

Table 3: Evaluation Criteria Including Weights and Ranking

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizes odours</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Achieves reliable operation and performance, simple to operate</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Demonstrated technology at scale and climate, low risk to City</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Provides operational flexibility to accommodate variability in flows and loadings</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Robust, low maintenance requirements</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Minimizes land area required, allow for future expansion or more stringent effluent requirements by 2031</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Criteria Matrix (Evaluated by Weight and by Rank)

- Expert panel reviewed each technology option and scored it from 1 – 5 (Table 4)
  - Score of 5: Best meets the criterion
  - Score of 3: Represents the middle of the alternative concepts
  - Score of 1: Least able to meet the criterion

- Score computed via 3 methods
  - Add scores for each technology
  - Multiply criteria weights with scores and tally
  - Multiply criteria ranking with scores and tally

Table 4: Double Weighted Criteria Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Derate to 300 MLD &amp; Construct in Parallel (Approx. 200 MLD)</th>
<th>Baseload Existing and Construct Second Stage Nitrification Plant</th>
<th>New CAS with with Replacement of Existing CAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAS</td>
<td>IFAS</td>
<td>MBBR</td>
</tr>
<tr>
<td>Tertiary Filter Capacity Requirement (ML/d)</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>1. Minimizes odours</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2. Achieves reliable operation and performance, simple to operate</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3. Demonstrated technology at scale and climate, low risk to City</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4. Provides operational flexibility to accommodate variability in flows and loadings</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5. Robust, low maintenance requirements</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
6. Minimizes land area required, allow for future expansion or more stringent effluent requirements beyond 2031

<table>
<thead>
<tr>
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<th>4</th>
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<th>2</th>
<th>4</th>
<th>5</th>
<th>3</th>
<th>4</th>
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7. Potential to phase in capacity (to closely match growth in organic load)

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<th>3</th>
<th>3</th>
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<th>1</th>
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<th>1</th>
<th>2</th>
</tr>
</thead>
</table>

8. Minimizes potential impact to operations during construction

|       | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 2 |
|-------|---|---|---|---|---|---|---|---|---|---|---|

9. Minimize time required to implement (development pressure, Harbour clean-up, funding)

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<tr>
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<th>2</th>
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<th>3</th>
<th>3</th>
<th>4</th>
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<table>
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<th>26</th>
<th>24</th>
<th>25</th>
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<th>26</th>
<th>22</th>
<th>25</th>
<th>35</th>
<th>28</th>
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<td>Rank</td>
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<td>6</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Weighted total (by weight)</td>
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<td>119</td>
<td>109</td>
<td>113</td>
<td>164</td>
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<td>11</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Weighted total (by criteria ranking)</td>
<td>130</td>
<td>128</td>
<td>112</td>
<td>109</td>
<td>178</td>
<td>121</td>
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<td>11</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

5 technology concepts consistently in top 5 for all 3 methods
- Derate existing plant to 300 MLD (with nitrification) and construct a parallel CAS rated for 200 MLD, plus tertiary filtration rated for 500 MLD
- Derate existing plant to 300 MLD (with nitrification) and construct a parallel MBR rated for 200 MLD, plus tertiary filtration rated for 300 MLD for existing CAS plant
- Baseload existing plant and construct a second stage nitrification plant using tertiary MBR. No added filtration necessary
- New CAS as well as replacement of existing CAS, plus tertiary filtration rated for 500 MLD
- New IFAS as well as replacement of existing CAS tanks with IFAS, plus tertiary filtration rated for 500 MLD

Technology concepts #4 and #5 are the same except for potential design for IFAS instead of CAS; therefore will combine for further analysis
3.8 DESIGN CONCEPT WORKBOOKS FOR SHORT LISTED TECHNOLOGIES

- Expert Panel completed design concept workbooks to analyze short listed technologies further. Information within workbooks include:
  - Description of processes and phasing plan
  - Anticipated Effluent Quality
  - Construction Plan/Issues
  - Capital and Operating Costs

- Potential schedule for each technology was created

3.9 CONCLUSION

The following list of best technology concepts were established for further evaluation within the next phase of the Class EA process:

1. Derate existing CAS plant to 300 MLD (12 day SRT for nitrification) with minor upgrades, and construct parallel 200 MLD CAS plant in the northeast site area. Construct tertiary sand filters for 500 MLD.

2. Derate existing CAS plant to 300 MLD (12 day SRT for nitrification) with minor upgrades and provide tertiary granular media filtration for the CAS plant. Construct a parallel 200 MLD MBR in the northeast site area.

3. Derate existing CAS plant to 300 MLD (12 day SRT for nitrification) with minor upgrades and provide tertiary membrane filtration for the CAS plant. Construct a parallel 200 MLD MBR in the northeast site area.

4. Derate existing CAS plant to approximately 400 MLD (3 day SRT with no nitrification) with minor upgrades. Construct a tertiary MBR in northeast site area to provide capacity to treat 100 ML/d primary effluent plus tertiary nitrification of 400 MLD (400 MLD from secondary effluent.

These concepts will be analyzed further to establish the best technology treatment for the Woodward Avenue WWTP.
Woodward Avenue WWTP
Treatment Options
Expert Panel No. 2
Class EA Phases 3 and 4
May 29, 2007

Workshop Purpose

- Review/confirm technology concepts for Woodward Avenue WWTP
- Review and refine scoring for highest scoring concepts
- Recommend single plant design concept
Workshop Agenda

- Recap
- Capacity and performance criteria
- Evaluation criteria and methodology
- Detailed review of options
  - Raw wastewater pumping
  - Disinfection
  - Primary Treatment
  - Combined primary/secondary tertiary
- Next steps
Recap

**Expert panel in December 2006**
- Screened long list of technology options
- Developed short list based on combinations of:
  - CAS
  - Tertiary filtration
  - MBR
  - Tertiary MBR
  - Membrane filtration

Recap

**Since December project team**
- Defined 6 secondary tertiary options
- Defined 6 primary options
- Developed and finalized evaluation criteria and weighting
- Developed capital, operating and life-cycle costs
- Completed draft comparative evaluation of alternatives

**Class EA process**
- Public meeting last week in June 2007
- File ESR in August 2007
Capacity and Performance Criteria

Woodward Avenue WWTP

- Average capacity: 409 ML/d → 500 ML/d
- Peak primary capacity: 614 ML/d → 1,300 ML/d
- Peak secondary/tertiary capacity: 614 ML/d → 1,000 ML/d
- Nitrification: none → year round
- Phosphorus removal: 0.8 mg/L → 0.15 mg/L
- Disinfection: seasonal → seasonal and non-toxic

Bioxolide (Master Plan)
- Currently digestion and dewatering
- Future – some digestion (potentially), dewatering and incineration
Capacity and Performance Objectives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current</th>
<th>Future</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average day flow (ML/d)</td>
<td>409</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Peak sustained flow (ML/d) – primary</td>
<td>614</td>
<td>1,300</td>
<td>To treat wet weather flow</td>
</tr>
<tr>
<td>Peak sustained flow (ML/d) – secondary/tertiary</td>
<td>614</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Peak hourly flow (ML/d) disinfection</td>
<td>614</td>
<td>1,700</td>
<td>Pumping station</td>
</tr>
<tr>
<td>CBOD₅ (mg/L)</td>
<td>15</td>
<td>5</td>
<td>capacity</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>15</td>
<td>3</td>
<td>Tertiary treatment</td>
</tr>
<tr>
<td>Ammonia-N (mg/L)</td>
<td>No limit</td>
<td>2/6</td>
<td>Year-round nitrification</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>0.8</td>
<td>0.15</td>
<td>Tertiary treatment</td>
</tr>
<tr>
<td>E. Coli</td>
<td>200 org/100 ML (seasonal)</td>
<td>200 org/100 ML (seasonal)</td>
<td>To be confirmed</td>
</tr>
</tbody>
</table>

Considerations

✦ Existing north and south plant
  - Capacity derated to 270 ML/d with nitrification
  - Capacity is about 320 ML/d with no nitrification – limited by secondary clarifier surface area

✦ Hydraulics
  - Intermediate/effluent pumping is required to raise hydraulic gradeline for new processes
  - Outfall capacity may not be adequate for peak flow
Considerations (cont'd)

- Site
  - Biosolids
  - Location of outfall
  - Relocation of rail line

Evaluation Criteria and Methodology
Development of Evaluation Criteria

- Evaluation criteria developed with City input
- Weight of each criteria developed by City's project team
- Criteria reflect 'triple bottom line'
  - Environmental 41%
  - Social 25%
  - Economic 34%
- Each option will be given a score (1 to 5) reflecting ability to meet criterion

Environmental Criteria

- Flexibility/reliability 10%
- Operational simplicity 6%
- Demonstrated technology 8%
- Constructability 8%
- Energy efficiency 5%
- Performance for emerging contaminants 2%
Social Criteria

- Potential odours: 9%
- Land use, future site capacity: 5%
- Meets schedule or can accelerate: 5%
- Aesthetics: 3%
- Impacts during construction: 3%

Economic Impacts

- Life cycle costs: 27%
- Financial risk: 5%
- Future costs beyond 2031: 2%
**Methodology**

- 6 Primary treatment options were evaluated
  - 3 top scoring options combined with 6 secondary/tertiary options
  - Total 18 options → reduced to 16

- **Disinfection**
  - Independent of upstream treatment process

**Detailed Review of Options**
Long List of Treatment Options

- Options were developed for the following plant components:
  1. Raw wastewater pumping
  2. Primary treatment
  3. Secondary/tertiary treatment – today's workshop
  4. Disinfection
  5. Solids processing – Biosolids Master Plan
  6. Outfall – hydraulic capacity analysis not yet completed

Raw Wastewater Pumping

- Criteria and issues:
  Capacity expansion is not required for average day flows
  Operational constraints during peak flows due to small wet well

- Option:
  1. Upgrade and expand wet well capacity

- Conceptual design to be completed:
  On-going condition assessment
Disinfection

Criteria and Issues
- Peak capacity of 1,300 ML/d is required
  - 1,000 ML/d secondary/tertiary effluent
  - 300 ML/d primary effluent bypass
- Non-toxic disinfection method, seasonal

Options
- Gas chlorination with sodium bisulphite solution
- Gas chlorination with sulphur dioxide gas
- UV disinfection
  - 1,300 ML/d with chlorination/dechlorination
  - 1,000 ML/d with chlorination/dechlorination of primary effluent bypass

Disinfection

Recommended from evaluation
- Chlorination/dechlorination with sodium bisulphite

Rationale
- Chlorine rail car on-site for water treatment plant
- Lowest capital and life-cycle cost with seasonal chlorination
- Demonstrated effective technology

Potential considerations
- Need for reaeration?
- Automation and control to match chlorine demand during primary bypassing
Primary Treatment

- **Criteria and Issues**
  - Peak capacity required is 1,300 ML/d
  - Total capacity available, with on-going upgrades to eliminate hydraulic bottlenecks, is 1,300 ML/d
  - Peak SOR for existing is relatively high – limited redundancy

- **Options**
  1. Do nothing – total capacity 1,300 ML/d
  2. Chemically enhanced primary treatment (CEPT) – total capacity 1,300 ML/d
  3. Expand with 3 new primary clarifiers – firm capacity 1,300 ML/d
  4. Expand with 3 new primary clarifiers, CEPT – firm capacity 1,300 ML/d
  5. Expand with high-rate treatment capacity – firm capacity 1,300 ML/d
  6. Replace primary clarifiers with new high-rate treatment facility

Considerations

- **Conventional primary treatment**
  - Ability to pre-precipitate with iron and add polymer during peak periods would be provided
  - Hydraulic upgrades are required and included in cost

- **CEPT**
  - Based on continuous iron and polymer addition to achieve >50% BOD removal
  - Hydraulic upgrades are required and included in cost

- **High rate**
  - Pumping of primary effluent required due to anticipated head loss through lamellas
  - For full plant, hydraulic upgrade costs are not included
Secondary/Tertiary Concepts

1. New parallel CAS, tertiary granular media filtration
2. New parallel CAS, membrane filtration
3. Existing CAS with tertiary granular media filtration, parallel MBR
4. Existing CAS with tertiary membrane filtration, parallel MBR
5. Existing CAS with tertiary MBR
6. Retrofit existing CAS to operate as MBR

Option 1
CAS, Granular Media Filtration

- Existing North and South plants derated to 270 ML/d
- New 230 ML/d CAS plant
- New tertiary filters for 500 ML/d
- Effluent pumping
**Option 1 Schematic**

**Option 1 Highlights**

- Simple construction – can be off line
- CAS is demonstrated, proven technology – operation staff are familiar
- Relocation of WAS thickening, gas globe is required
- Largest site area requirement – limits future site capacity
- Comments?
Option 2
CAS, Membrane Filtration

- Existing North and South plants derated to 270 ML/d
- New 230 ML/d CAS plant
- New membrane filters for 500 ML/d
- Effluent pumping
Option 2 Highlights

- Simple construction – can be off line
- Relocation of WAS thickening is required
- CAS is demonstrated, proven technology – operation staff are familiar
- Membranes for tertiary filtration - not demonstrated in wastewater but good water treatment experience
- Largest site area requirement – limits future site capacity
- Comments?

Option 3
Existing CAS with Granular Media Filter
New Parallel MBR

- Existing North and South plants derated to 270 ML/d – new granular media filter
- New 230 ML/d MBR
Option 3 Schematic

Option 3 Highlights

- Simple construction – can be off line
- CAS is demonstrated, proven technology – operation staff are familiar
- Large MBR relative to industry experience
- Complexity of operating 2 separate treatment plants
- Small site area requirement – future site capacity available
- 20-Year NPV Operating Cost: $76 million
- Comments?
Option 4
Existing CAS with Membrane Filter
New Parallel MBR

- Existing North and South plants de-rated to 270 ML/d - new membrane filter
- New 230 ML/d MBR
- MBR and membrane filter in single facility, common ancillary equipment
Option 4 Highlights

- Simple construction – can be off line
- CAS is demonstrated, proven technology – operation staff are familiar
- Large MBR relative to industry experience
- Common membrane technology
- Complexity of operating 2 separate treatment plants
- Small site area requirement – future site capacity available
- Comments?

Option 5
Existing CAS with Tertiary MBR

- Existing North and South plants non-nitrifying – 409 ML/d average, peak bypass directly to tertiary MBR
- New 500 ML/d tertiary MBR
Option 5 Schematic

Option 5 Highlights

- Simple construction – can be off line
- CAS is demonstrated, proven technology – operation staff are familiar
- Limited tertiary MBR experience in industry
- Single treatment train
- Small site area requirement – future site capacity available
- Comments?
Option 6
Retrofit Existing Plant to MBR

- Retrofit existing north aeration tanks to be bioreactors for MBR process – hydraulic for 500% RAS
- Construct new tanks for membrane cassettes and ancillary equipment

Option 6 Schematic

[Diagram showing the flow of water through the plant with various flow rates and capacities indicated]
Option 6 Highlights

- Must follow CEPT - difficult to provide adequate aeration due to tank configuration
- Constructability
  - Hydraulic upgrades to aeration tanks challenging - channels, gate
  - Phasing to maintain capacity on-line during construction
- Limited large plant MBR experience in industry
- Single treatment train
- Smallest site area requirement - future site capacity available
- Comments?

Summary of Capital Costs and Operating Costs
Scoring Results
Primary/Secondary/Tertiary

Results

- 5 options represent:
  - Highest overall score
  - Lowest capital cost
  - Lowest operating cost

1. Expand with CAS
3. CAS with granular media filter/parallel MBR
4. CAS with membrane filter/parallel MBR

Total Score (out of 100%)
Finalizing Preferred Alternative

- Expert Panel
  - Are new primary clarifiers required?
  - What are true O&M impacts?
  - What is risk associated with MBR, membrane filters at this scale
  - Has cost of construction been addressed?
  - Are there constructability concerns that have not been addressed?

- Detailed Review of Options

Next Steps

- Technical Memorandum – Evaluation of Options
- Presentation to Public Works Sub-Committee on June 4, 2007
- Presentation to CLC and TAC on June 14, 2007
- Public Meeting at end of June, 2007