LITERATURE REVIEW

Project Constraints
Before beginning the project, we had to determine the constraints that limit us. These constraints are primarily legal.
• APHIS constraints - Animal and Plant Health Inspection Service
• The Chicago Zoological Society (CZS) Constraints
• AALSO - A Field Guide to Water Quality Practices
• Client Constraints

Professional Standards
There are also professional standards set in place, these standards are:
• The National Swimming Pool Foundation - “Pool Operator Handbook”
• “Marine Aquarium Reference Systems and Invertebrates”
• Sterilization of Marine Mammal Pool Waters – USDA.

Unit Processes researched:
The below unit processes are what we found to be the most important aspects of the system and worth focusing research on.
• Coagulation and Flocculation
• Sand Filtration & Sedimentation Basins
• Clarifiers

Simplified System Diagram
To understand the current system in place, an in depth analysis of diagrams was conducted and a simplified diagram was created.

PROJECT DESCRIPTION

The life support system of the Seven Seas dolphin exhibit and Pinniped Point treats 15 million gallons of water through a complicated series of unit processes every day. Our sponsor, Brookfield Zoo, asked us to look at the current setup and find possible improvements to increase the efficiency and efficacy of the system. The suggested improvements must fit in with the current system and abide by all constraints provided by Brookfield Zoo and various standards.

EXPERIMENTATION AND TESTING

Experimentation consisted of testing the following:
• Total suspended solids
• Dissolved Oxygen
• Nitrates & Nitrites
• Phosphates
• Coagulants
• Flocculants
• Ammonia

The above experiments were conducted to determine what aspects of the system should be focused on, and what solutions may be present.

Testing
After testing each coagulants’ ability to coagulate, their supernatants were tested to find their ability to remove nitrates and phosphates.

Another test is being conducted to determine the effectiveness of the biological film in the sand filters to remove nitrates and phosphates.

Impact of testing on the decision
Our results will determine which solution is best, a coagulation/flocculation combo and clarification decision or alterations to the sand filters. This will be determined by the most cost-effective solution that removes the most constituents.

RESULTS

They represent the testing of each coagulants ability to remove constituents from water in two different sources of water.

<table>
<thead>
<tr>
<th>Coagulant</th>
<th>Nitrate Testing</th>
<th>Phosphate Testing</th>
<th>PII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Testing</td>
<td>87</td>
<td>69.25</td>
<td>.94</td>
</tr>
<tr>
<td>Baseline Testing 2</td>
<td>125.5</td>
<td>48</td>
<td>7.93</td>
</tr>
<tr>
<td>30 ppm ferric chloride 1</td>
<td>126.5</td>
<td>46.25</td>
<td>43.75</td>
</tr>
<tr>
<td>30 ppm ferric chloride 2</td>
<td>130.5</td>
<td>33.25</td>
<td>34.5</td>
</tr>
<tr>
<td>30 ppm ferric chloride 3</td>
<td>127</td>
<td>41</td>
<td>36.25</td>
</tr>
<tr>
<td>40 ppm ferric chloride 1</td>
<td>126</td>
<td>65.25</td>
<td>34.25</td>
</tr>
<tr>
<td>40 ppm ferric chloride 2</td>
<td>118.5</td>
<td>42</td>
<td>43.25</td>
</tr>
<tr>
<td>50 ppm ferric chloride 3</td>
<td>116.5</td>
<td>50.75</td>
<td>39.75</td>
</tr>
<tr>
<td>50 ppm ferric chloride 4</td>
<td>108.5</td>
<td>55</td>
<td>38.5</td>
</tr>
<tr>
<td>60 ppm ferric chloride 5</td>
<td>121</td>
<td>44.5</td>
<td>47.25</td>
</tr>
<tr>
<td>70 ppm ferric chloride 6</td>
<td>90</td>
<td>44.5</td>
<td>41.25</td>
</tr>
<tr>
<td>80 ppm ferric chloride 7</td>
<td>74</td>
<td>50.75</td>
<td>48.25</td>
</tr>
<tr>
<td>90 ppm ferric chloride 8</td>
<td>87</td>
<td>40.5</td>
<td>46.75</td>
</tr>
</tbody>
</table>

Table 1: Shows nitrate and phosphate levels of coagulant supernatant

NEXT STEPS

We have located two ideal spots to install coagulation/flocculation and clarification tanks. Before we can make a final conclusion we will:
• Get quotes from companies that build clarifiers
• Make a 3D model of a clarifier of our own design
• Develop a cost analysis on the clarifier, increased piping, coagulant costs, and increased electric demands
• Compare our options and make a decision based on effectiveness, affordability, and low risk