5.0 COST EVALUATION AND RECOMMENDATIONS

5.1 Present Worth Opinion of Cost evaluations

The cost to install the four alternatives has been evaluated. Costs include all capital and operation and maintenance (O&M) costs. Using life cycle cost analyses helps correctly assess the most effective alternative. In a present worth comparison of alternatives, the costs associated with each alternative are all converted to a present sum of money, and the least of these values represents the best financial alternative. Annual costs over thirty years, future payments, and gradients must be brought to present value.

The present worth comparisons utilized in this report are *strictly for comparisons* and not actual cost estimations/determinations of the respective alternatives. Costs for site preparation, mobilization, demobilization, indirect costs, restoration, etc. were extrapolated from anticipated costs and scaled to match the anticipated requirements of each alternative. Important differences for each of the respective alternatives were also included to facilitate a comparison of the four alternatives present worth values. No brine disposal costs were included for Alternatives 2 and 3 since our investigations did not discover any solutions that were not extremely cost prohibitive. These alternatives are considered no longer viable. Estimated cost data for the four alternatives are shown below. See Appendix O for the detailed present worth alternative comparison.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Capital Cost	$7,221,756	$8,2411,704[8]	$2,770,149[8]	$803,000
Useful Life	30 Years	30 Years	30 Years	30 Years
O & M costs				
• City	$3,000/yr	$187,227/yr[8]	$460,879/yr[8]	$0/yr
• Homeowners	$0/yr[9]	$0/yr[9]	$166,923/yr[8]	$10,000/yr
Present Worth	$7,267,873	$11,289,844	$9,854,989	$956,725

Alternative 1: Provide City of Chesapeake Water via a Water Main Extension.
Alternative 2: Install a Community Groundwater Supply, Treatment, Storage, and Distribution System.
Alternative 3: Install Point of Entry (POE) Treatment Systems on Existing Private Wells.
Alternative 4: Development and Installation of New Private Wells into Yorktown-

[8] Costs do not include brine disposal

[9] Each residential connection shall have a separate service connection to the City of Chesapeake water supply. The city will maintain all service connections, including the meter facilities. ***The house connection shall be installed and maintained by the customer at their own expense and in accordance with the standards established by the City Public Utilities Department***. The customer shall, at their own risk and expense, furnish, install and maintain in safe condition all equipment that may be required for receiving, controlling and utilizing water as the house connection.

Eastover aquifer.

The present worth value of each alternative is displayed above assuming:

1) Money is worth 5%, annual compounding,
2) Zero salvage value,
3) All other costs equal for all alternatives,

Present worth was determined as in the below example for Alternative 2:

Present Worth (Alternative 2) = P + A (P/A, 5%, 30)

$$= P + A\frac{\left[(1+i)^N - 1\right]}{\left[i(1+i)^N\right]}$$

$$= 7{,}226{,}226 + 192{,}143\frac{\left[(1+0.05)^{30} - 1\right]}{\left[0.05(1+0.05)^{30}\right]}$$

$$= 10{,}179{,}934$$

Alternative 4 is the least costly, while Alternatives 1 and 3 are comparable from a capital cost perspective, and Alternative 2 is the most expensive. Alternatives 1 and 4 benefit from a considerably reduced operations and maintenance (O&M) cost. The capital cost and O&M costs required for Alternative 2 make this choice not preferred from a present worth analysis. Likewise, Alternative 3 has such extensive O&M costs, that it is the least preferred from a present worth analysis perspective.

O&M costs have been divided between the City and Homeowners for each option. Alternatives 1 and 2 depict all the O&M costs being paid by the City. Alternative 3 shows a division of cost responsibility with the City absorbing the operations and sampling cost of the individual treatment units, while the homeowners pay for the electric and sanitary sewer disposal costs for the brine. All operational costs associated with Alternative 4 will be paid by the homeowner and would include electric and maintenance of the well system.

5.2 Alternative Evaluation Matrix

While a present worth analysis is invaluable in evaluating alternatives it should not be the only consideration. In this evaluation a decision matrix was developed which considered six categories of criteria to assess the alternatives. The six categories are as follows:

1. Regulatory Compliance – Water Quality
2. Property Owner Impact
3. Operational Requirements
4. Technical Feasibility
5. Present Worth

6. Permitting / Administrative Burdens

Each category was further sub-divided into specific criteria and given a relative weight of importance on a scale of 0 - 10 (no importance rated 0, most important rated 10). The amount of "relative importance" is a comparison between the importances of the criteria. For example, as discussed below Regulatory Compliance is considered more important than Operational Requirements. A brief description of each follows below with a justification of its relative weight of importance.

Regulatory Compliance-Water Quality
The two specific criteria for this category are:

1) Meets VA Drinking Water Standards, and
2) Long Term Compliance.

The criterion of providing safe drinking water that meets all applicable standards is the baseline for all future actions and was given a rank of 10. Equally important is insuring future water quality and maintaining long term compliance. This was also given a rank of 10. Overall Regulatory Compliance – Water Quality contributes 20% to the overall weighted score.

Property Owner Impact
An important component for the evaluation of alternatives is property owner impact. This category was subdivided into two criteria:

1) Affect Property Value, and
2) Homeowner responsibilities, increased burdens, safety

Obviously an inherent component to a home's marketability and value is the assumption that safe and potable drinking water is reliably available to perpetuity. The effect of the alternatives on the Home Property Value was given a rank of an 8. Equally important is the added burden to the homeowner to have this safe potable drinking water. The burdens include costs to obtain water (connections fees), cost for water use, increased energy consumption, access issues for City of Chesapeake run facilities, safety concerns with unknown personnel required to monitor systems among others. The Homeowner Responsibilities/Increased Burdens/Safety was given a rank of an 8. Overall Property Owner Impact contributes 16% to the overall weighted score.

Operational Requirements
The alternative selected should minimize waste generation, conserve resources, reduce energy expenditure and minimize greenhouse gases, and minimize impact on public resources (aquifers). These were collectively grouped into the criteria of Sustainability and given a rank of 8. Secondly, operational requirements should be fail safe. The selected alternative should have enough redundancy and reliability that future operational risks are minimized or eliminated. Also the selected alternative should have minimum complexity and ease of use so that safe water will always be available with a minimum of any

interruption of service. Reliability was given a rank of 8. Overall Operational Requirements contribute to 16% of the overall weighted score.

Technical Feasibility
This category is governed by the time required for implementation, constructability, and the protection of the public welfare. Time is an important component in the alternative matrix because of the ramifications of a rapidly affected water source. In the event that water quality conditions in a water source were to decline, a rapidly implementable alternative for supplying potable water will be of utmost importance. The course of action should avoid complexity and reduce potential exposure to injury and/or release of contaminants. Constructability was given a rank of 6. Time for Implementation was given a rank of 8. This category contributes to 14% of the overall weighted score.

Present Worth
The present worth comparisons as described in the previous section were utilized in this category. The criteria of this category were capital and O&M costs. The necessary capital outlay to construct the project was given a rank of 10 while the O&M costs were given a rank of 10. This decision matrix weighted the Present Value of Costs as 20% of the overall importance.

Permitting / Administrative Burdens
This final category considers the necessary administration effort required to make the selected alternative a reality. Such burdens include permitting, zoning, pilot testing, public meetings and discussions, and administering construction contracts, among others. The permitting was given a rank of 8. The level of effort criterion was given a rank of 6. Overall the administrative burdens contribute 14% of the overall weighted score.

After the assignment of a relative weight between the various criteria each of the four alternatives was given a rating according to their anticipated performance with respect to the various criteria. The ratings follow a scale of 0 to 5 (exceptionally unfavorable rated 0 and exceptionally favorable rated 5). These rating were than multiplied by the relative weight to get a weighted rating. The sum of the weighted ratings for each of the alternatives resulted in total score with the highest score being the most favored. The details of the alternative decision matrix is presented in Appendix P.

The decision matrix shows Alternative 1 as the most desirable.

5.3 Recommended Alternative

It is understood that other, more comprehensive groundwater studies are currently being conducted in the area. Groundwater movement in this region is difficult to accurately predict in terms of leakage from one aquifer to another. The thickness and homogeneous characteristics of the confining zones could significantly vary in the study area, even from one street to the next. Therefore, the level of protection that may be provided by the confining zone between the Surfical and Yorktown-Eastover aquifer can not guarantee the

prevention of downward migration. Further, well construction techniques for most, if not all, of the existing wells withdrawing from the Yorktown-Eastover aquifer were most likely installed utilizing well construction methods that actually facilitate migration between the two aquifers. The migration or leakage (which has not been confirmed) could take place along the outside of the casing pipe since grouting between the exterior of the pipe and the confining zone typically is installed only 20 feet from the surface. The confining zone at the site is typically located some 50-60 feet below the surface.

The potential introduction of contaminants from the Golf Course fly ash into the Surficial aquifer through a leaching effect is a time consuming investigation and was beyond the scope of this study. However, the intent of this study was to identify implementable water source alternatives in an expeditious manner in the event that contamination was to occur. Based on the available information, it is not known if contaminants will leach from the fly ash and result in contamination of nearby wells. The data that was available to URS for this study does not show conclusive evidence that groundwater contamination from the Battlefield Golf Course property has migrated to residential water wells in the immediate vicinity. However, the threat of such an event is possible.

With the study area located within the Eastern Virginia Groundwater Management Area, it is considered unlikely that DEQ would approve a large groundwater withdrawal in this area with the availability of high quality City water in the vicinity. The City's drinking water meets all state and federal drinking water regulations and is closely monitored on a daily basis. The identification of regulatory-acceptable and cost effective means of brine waste disposal from an RO process – community system or individual systems, is doubtful.

Based on the investigations of the alternatives evaluated to supply potable water to the homes in the vicinity of the Battlefield Golf Course, it is recommend that the City proceed with the construction of Alternative 1 and extend the City distribution system to serve these areas. The provision of City water would allow for a safe, reliable, monitored water supply that would be most protective against any potential future impacts to the existing aquifer supply.