EXECUTIVE SUMMARY

ES.1 Introduction

This project was commissioned and sponsored by the City of Rapid City, South Dakota. Due to development in the Elk Vale vicinity (northeast Rapid City), the City has elected to pursue the expansion of its water distribution system and retained the team of Advanced Engineering and Environmental Services, Inc. and Kadrmas, Lee, & Jackson, P.C. (AE2S/KL&J) to complete this Preliminary Engineering Report. The study area is shown in Figure ES.1, and is consistent with the Tier 1 Planning Area boundary used for the Utility System Master Planning efforts.

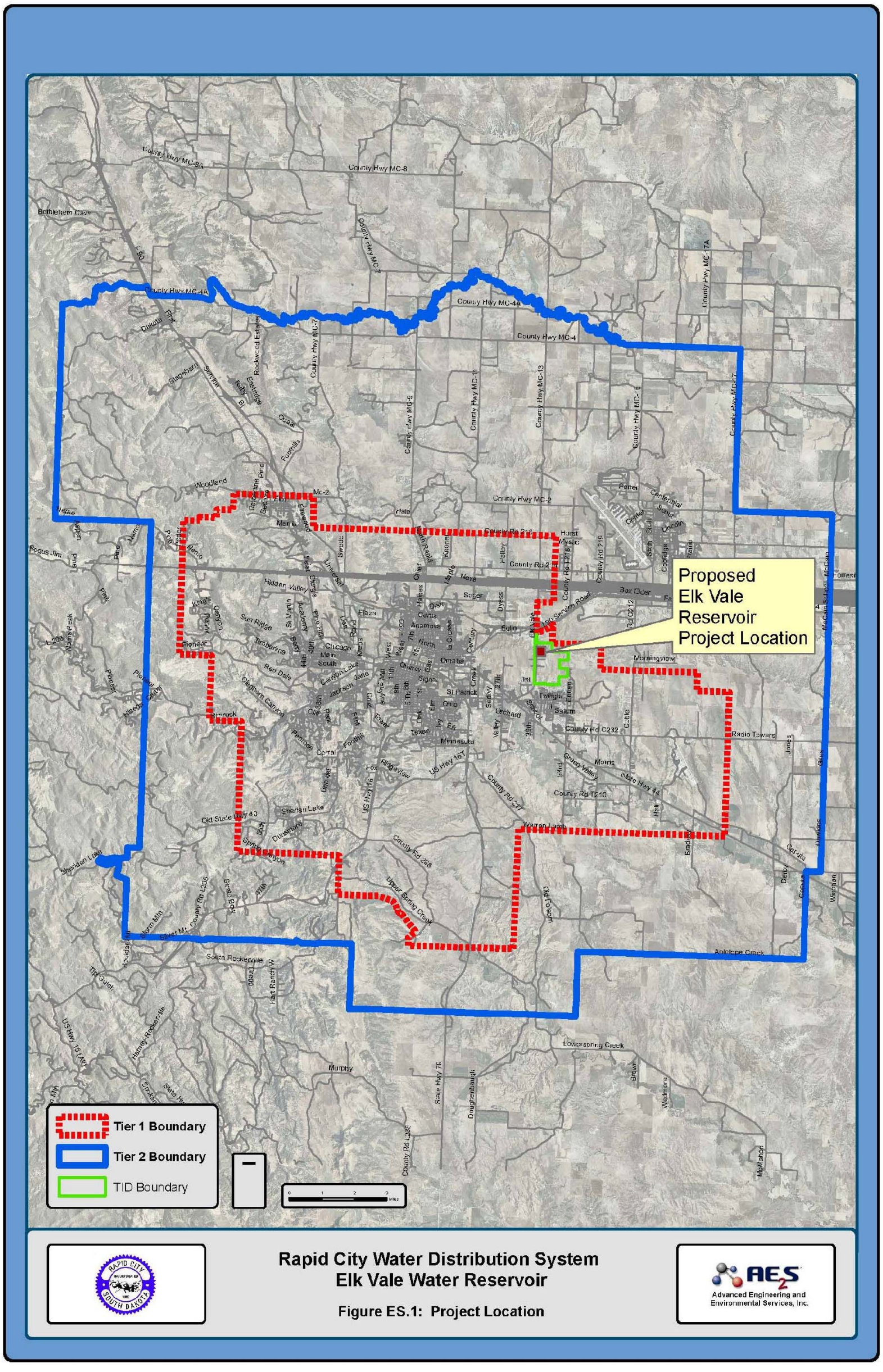
This Preliminary Engineering Report includes the evaluation and recommendation of infrastructure improvements necessary to provide water storage for both the Elk Vale Low Level and Elk Vale High Level pressure zones. This report also examined topography, piping, materials, and reservoir configurations, and provides guidance on how proposed reservoirs affect water service to the Airport, Water Reclamation Facility, Green Valley, Rapid Valley and City of Box Elder.

The AE2S/KL&J team evaluated water storage for operation, fire flow, and emergency demands. This report details how the project team reviewed existing and future demands, and used computer modeling (MWHSoft InfoWater) to develop reservoir sizing and predict how proposed reservoirs interact with the existing water distribution system. Existing studies and reports were reviewed to determine which previous considerations were still valid and could be further refined and incorporated into the work of this assignment.

ES.2 Project Service Area

The Tier 1 growth area (as established by the City to define the geographic boundary of future growth for planning purposes) includes the Elk Vale area, as indicated in Figure ES.1. In order to meet current and future demands, the study for the Elk Vale service area included the Downtown/Skyline Drive, North Rapid, Northeast, Elk Vale Road, and Southeast Connector neighborhoods. This study area includes both the existing Low Level and North Rapid High Level pressure zones, which are presented in Table 2.1.

Table 2.1 indicates that in order to provide water service to customers at higher elevations in the Elk Vale service area, water must be pumped to a new High Level elevated reservoir. Customers between elevations 3232 and 3300 could be served by either the Low Level or High Level zones; however, service from a new Low Level reservoir would only provide 40 psi (pounds per square inch) pressure. Serving customers in this transition region (Elevation 3232 to 3300) from the new High Level elevated reservoir will provide pressures in the 105 to 135 psi range.


Proposed
Elk Vale
Reservoir
Project Location
Tier 1 Boundary
Tier 2 Boundary
TID Boundary
Rapid City Water Distribution System
Elk Vale Water Reservoir
Figure ES.1: Project Location
Advanced Engineering and
Environmental Services, Inc.

ES.3 Water Demand Projections and Land Use Allocation

Historical and projected water demands, population projections, water production records, and customer billing records were examined to project demands for the Elk Vale service area. Demands are presented in Table 3.5. Various factors used to predict Elk Vale demands and reservoir sizing are discussed in Chapter 3 including; Peaking Factors, Equalization Storage, Land Use Projections, Buildout Population, and Box Elder demands.

ES.4 Pumping and Water Storage

Water storage facilities are sized to; (1) meet equalization storage, (2) meet fire fighting demands, and (3) to provide reserves for emergencies. Hydraulic analyses were performed to determine equalization storage as discussed in Chapter 3.

Fire storage volume is determined by multiplying fire demand by the required flow duration of a fire event. The project team discussed Elk Vale fire demands and durations with the Rapid City Fire Department. Since the Elk Vale Low Level area includes commercial and industrial customers, a 4,000 gpm fire demand for a four hour period was selected to determine the fire storage (960,000 gallons). Since the Elk Vale High Level area is largely residential, it was determined the High Level reservoir would require 300,000 gallons for fire storage to provide for a 2,500 gpm fire demand over a two hour period.

There are no "formulas" to determine an appropriate amount of emergency storage; however, the Rapid City Draft Design Criteria Manual suggests emergency storage equal the average day demand. If Rapid City implements rationing during an emergency, the reservoir size does not need to be increased for emergencies (i.e. the selected size for equalization and fire storage provides sufficient storage volumes for emergencies). This rationale received the concurrence of the Rapid City Engineering Division.

Figure 4.1 shows the total storage required for the Elk Vale Low Level Service Area is 3.5 million gallons (MG). It is important to note that additional storage will be needed to serve other areas of the Low Level pressure zone in the future. It was also determined that the Elk Vale Low Level Reservoir would reach buildout capacity in 85 to 90 years.

Figure 4.1 also shows the total storage required for the Elk Vale High Level Service Area to be 1.25 MG. Here again, additional storage will be required to serve other areas of the High Level zone in the future. It was also determined that the Elk Vale High Level Reservoir would also reach buildout capacity in 75 to 80 years.

A portion of the area in western Box Elder could also be served by the new Elk Vale reservoirs; therefore, the project team evaluated future Box Elder demands for this area similarly to the

exercises completed for the Elk Vale Service Area. It was determined that total buildout of the Box Elder area will have 0.8 MGD (million gallons per day) average day demands and 2.0 MGD peak day demands.

The Box Elder storage was calculated to be 0.44 MG (which for practical purposes was rounded to 0.5 MG). In order for the Elk Vale Low Level reservoir to provide this storage volume, the proposed reservoir would need to be increased from 3.5 to 4 MG. Additional fire flow storage was not deemed necessary or added because it was assumed that the fire storage provided is adequate for the zoning of the Box Elder area. Conversely, if Box Elder were to construct a reservoir for their needs, they would likely require a 1.5 MG reservoir (0.44 MG equalization storage and 0.96 MG fire flow storage).

ES.5 Hydraulic Analysis

The proposed 3.5 MG Low Level Reservoir will be hydraulically connected to the existing reservoirs at Signal Hill. The proposed reservoir will also have the same overflow elevation as the existing reservoirs to allow all reservoirs to "float" together. In order to completely fill the new reservoir, control valves will be required on both existing Signal Hill reservoirs. Since the City's water supply is located in the western part of the city, water flows first to Signal Hill and then to Elk Vale. Figure 5.3 illustrates how, under peak day demand conditions, the proposed Elk Vale Low Level reservoir fills only to 45 percent of its total volume if control valves are not installed. However, Figure 5.4 illustrates how the proposed reservoir fills completely when control valves are installed at Signal Hill. Water age analyses were also completed for short and long-term operations of the proposed reservoir, and found to be satisfactory.

ES.5.1 Fire Flow at the Airport

The proposed 3.5 MG Elk Vale Low Level Reservoir slightly improves fire flow capacity at the Rapid City Airport (from 2,000 to 2,100 gpm). The limiting factor for the airport is the existing 12-inch water main. The project team modeled a new 12-inch pipe along Homestead Street, east to Radar Hill Road, and then south to loop into the existing 12-inch pipe that serves the airport. This scenario increased fire flow at the airport to 2,900 gpm. If the proposed pipe in this scenario is increased to 16-inch, the fire flow increases to 3,200 gpm. Other potential solutions to improve fire flow to the airport include: replacement of the existing 12-inch water main with a larger pipe; or, constructing a dedicated reservoir at the airport.

ES.5.2 Elk Vale High Level Pressure Zone

In order to fill the proposed 1.25 MG Elk Vale High Level Reservoir, a pump station will be required. The pump station includes three 800 gpm pumps that draw water from the proposed 3.5 MG Elk Vale Low Level Reservoir to fill the 1.25 MG Elk Vale High Level Reservoir. The general layout of the pump station is shown in Figure 6.5. In the future, it is anticipated that

piping will be installed to connect the proposed Elk Vale High Level zone with the existing North Rapid High Level zone, thus providing the ability to share pumping and storage capacity between reservoirs and zones. After the connecting pipe is installed, the 1.25 MG Elk Vale High Level Reservoir and the existing 2 MG North Rapid High Level Reservoir will interact well, without the need for level controls. In the interim, before connecting pipe is installed, it is recommended that the 1.25 MG Elk Vale High Level Reservoir be connected to the Industrial Park (near East Anamosa Street and Elk Vale Road) to provide initial demands to ensure turnover of water within the proposed reservoir.

ES.5.3 Future Reservoirs & Pipelines

Although extensive modeling was not completed beyond the scope of this report, the project team did identify the need for future reservoirs in the Low Level, High Level, and Low Low Level as the City expands. The size and location of these future reservoirs will be determined through future planning efforts.

ES.6 Reservoir Siting

Siting for the 3.5 MG Elk Vale Low Level Reservoir and the 1.25 MG Elk Vale High Level Reservoir began with existing reservoir overflow elevation data, head range values, pump station concepts, and hydraulic analyses. The existing ground elevations necessary to minimize project costs were found generally south of I-90 between Elk Vale Road and North Reservoir Road. This location is also desirable for other reasons such as its central location within the Tier 1 service area, and availability of power, access roads, transmission mains, etc.

Six sites were initially identified as shown in Figure 6.1. A preliminary geotechnical review of the six sites was performed by American Engineering Testing, Inc. and a thorough geotechnical evaluation is recommended during final design phase. The six sites were ultimately refined to two sites (west and alternate-west). From meetings with the landowner (G&G Investments LLP), the “alternate-west” site was recommended for final design. Figure 6.4 illustrates the conceptualized site and recommends the City purchase 6.4 acres for construction of the proposed infrastructure.

ES.7 Reservoir Materials and Configuration

ES.7.1 Elk Vale Low Level Reservoir

The four reservoir materials considered in this report include; welded or bolted steel (which was dropped for numerous reasons), reinforced concrete, wire and strand wound prestressed concrete, and internal tendon (post-tensioned) concrete.

The project team evaluated three main configurations for the 3.5 MG ground storage reservoirs; above-ground, partially buried, and buried. These configurations are shown in Figure 7.1, Figure 7.2, and Figure 7.3. Primarily due to cost and existing site grades, a partially buried configuration is proposed for the Elk Vale Low Level Reservoir. A circular shape was determined to be more efficient and cost effective. An overflow elevation of 3406 feet msl and head range of 20 feet was established. The selection of a circular reservoir shape results in a 173 foot diameter for a 3.5 MG reservoir, and 185 foot diameter for a 4.0 MG reservoir.

Additional aesthetic features are available; however, more elaborate architectural elements will result in higher costs. Figure 7.4 and Figure 7.5 illustrate fluted and brick pilasters, arches, and split face block. Costs for these features are estimated to range from $25,000 to $165,000. Colored concrete and brick treatments are also simple ways to improve aesthetics.

The prestressed concrete reservoir and post-tension reservoirs were determined to be the most cost effective and thus were recommended for final design. If the City finds both reservoir styles acceptable, final design documents could be prepared such that the most economical bid would determine which reservoir is constructed.

ES.7.2 Elk Vale High Level Reservoir

The four reservoir materials considered for the Elk Vale High Level Reservoir include; spheroidal multi-legged (which was dropped for numerous reasons), waterspheroid single pedestal, fluted column, and composite reservoirs. The overflow elevation will be set at elevation 3544 feet msl, and the operational head range will be 44.2 feet.

The three configurations have similar initial costs, but the waterspheroid single-pedestal and composite water reservoirs are more cost effective long-term, and thus were recommended for final design. If the City finds both reservoir styles acceptable, final design documents could be prepared such that the most economical bid would determine which reservoir is constructed.

ES.8 Recommendations

After reviewing the result of a decision matrix (Table 8.1) and meeting with the landowner, the "alternate-west" was selected as the preferred site. Preliminary discussions regarding land costs have been in the $50,000 range for the 6.4 acre site. The recommended materials for the 3.5 MG Elk Vale Low Level Reservoir are wire wound prestressed and post-tensioned tendon concrete. To take advantage of the site contours, the report recommends a partially-buried reservoir. Several aesthetic features are available and can be finalized in the design phase. The recommended reservoir styles for the 1.25 MG Elk Vale High Level Reservoir are the waterspheroid single-pedestal and composite water reservoirs.

ES.8.1 Cost Analysis

3.5 MG Elk Vale Low Level Reservoir		
Construction*	$	3,508,000
Geotechnical	$	15,000
40% Contingencies, Engineering, Legal, and Administrative	$	1,404,000
Subtotal	**$**	**4,927,000**
1.25 MG Elk Vale High Level Reservoir		
Construction**	$	3,581,000
40% Contingencies, Engineering, Legal, and Administrative	$	1,433,000
Subtotal	**$**	**5,014,000**
Total	**$**	**9,941,000**

Items not included in the above opinions of probable project costs include the following:

Land Acquisition for Site and Road Easement	$ 50,000
Asphalt Road Adder (in addition to gravel base)	$ 293,000
Architectural Features for Ground Storage Reservoir	$25,000 - 165,000
Emergency Generator	$ 165,000
WTP Master PLC Upgrade (necessary)	$ 350,000

ES.8.2 Tax Increment Finance District

In November 2003, Rapid City created Tax Increment Finance District (TID) No. 42 for Elk Vale water storage infrastructure (Low Level and High Level reservoirs). The opinions of probable costs developed in this report were compared with the 2003 TID cost estimates, which are summarized in Table 8.2. The 2007 cost opinions ($1.19 per gallon for the ground storage reservoir and $3.39 per gallon for the elevated reservoir) are significantly higher than the original 2003 TID costs ($0.71 per gallon for ground storage reservoir and $2.18 per gallon for elevated reservoir). In comparison, the Red Rock Reservoir was recently constructed for $1.06 per gallon. Elevated reservoir projects recently bid in the region have been, or are being constructed for about $2.50 per gallon without pump station improvements. Therefore, the 2007 opinions of probable costs appear to reasonably reflect the current construction market.

The City has five years from the TID approval date to accrue project costs; therefore, project bids must be received prior to November 30, 2008. In order to meet this deadline, the following schedule should be maintained:

Preliminary Engineering Report Completed…….	October 2007
City Council Approves Project Scope …….	October 2007
City Council Approves (Final Design) Engineering Agreement ……....	November 2007

City Acquires Land……..November 2007
Final Design Begins …… December 2007
Environmental Review/Assessment & Geotechnical…… December 2007
Public Information Meeting…… December 2007
Final Design Complete……..August 2008
Advertisement for Bids: …… September 2008
Bid Opening …… September 2008
City Council Approves …… October 2008
TID Project Costs Accrual Deadline……..November 30, 2008

ES.8.3 Utility Facility Fund

It is anticipated that the Utility Facility Fund will be utilized for design and construction of the Elk Vale Low Level Reservoir. This loan fund will provide $3,500,000 for the Elk Vale project and will be repaid with TID funds.

ES.8.4 Box Elder, South Dakota

The City of Box Elder recently contacted Rapid City requesting assistance to supply potable water for the Elk Vale area between Rapid City and Box Elder. In June 2007, the City agreed to evaluate the possibility of a combined project, and directed the project team to complete the following tasks; 1) land use allocation for Box Elder, 2) allocation of Box Elder demands to lands areas and develop demand projections, 3) analyze Box Elder storage requirements for the area, and 4) size Box Elder reservoir, as appropriate.

From the hydraulic analyses it was determined that if a combined project were pursued, the Elk Vale Low Level Reservoir volume would need to be increased by 0.5 MG (from 3.5 MG to 4 MG) to accommodate Box Elder demands. The costs to construct this larger reservoir are presented in Table 8.3; however, Box Elder should be aware that these costs are only a part of the total costs of a combined project. Future discussions between Box Elder and Rapid City should include the following:

1. Rapid City to maintain complete ownership of the reservoir, and the City Attorney draft an agreement with Box Elder that includes terms, quantities, monthly surcharges, etc.
2. Box Elder's 0.5 MG amounts to 12.5% of the total 4 MG reservoir capacity; therefore, a 12.5% cost sharing for engineering costs appears reasonable. Box Elder could expect design related invoices between December 2007 and September 2008.
3. Consecutive Users typically make an initial payment to Wholesalers and the exact amount should be negotiated between the leaders of both communities.