Enid Alternate Water Supply

Executive Summary

City of Enid, Oklahoma

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1.0 Introduction

The City of Enid, Oklahoma (City) has historically enjoyed an adequate supply of water resources to support consumers in Enid and its wholesale customers. However, the City's annual water demand has begun to exceed the annual yield of the existing groundwater supply, which has resulted in depletion of the aquifer system. To address this supply gap, the City initiated a Water Master Plan (by others) that recommended developing a new surface water supply from Kaw Lake to supplement the existing groundwater supply.

1.1 Proposed Kaw Lake Surface Water Supply

To satisfy the anticipated future water supply, the City of Enid's Citizen's Advisory Committee elected to pursue a new surface water supply from Kaw Lake with the acceptance of the Water Master Plan in August 2009. Kaw Lake was constructed on the Arkansas River by the United States Army Corps of Engineers (USACE). Ground was broken for the dam in 1966 and the lake was completed in 1976. The lake was constructed for flood control, hydropower, recreation, fish and wildlife, and to serve as a municipal water supply with a dependable yield of 128 MGD. Currently, the City of Stillwater, with a 50 MGD water right, is the only major municipality supplying water from Kaw Lake. The City of Enid has initiated discussions with the USACE for the required storage contract and has obtained the necessary water rights from the Oklahoma Water Resources Board (OWRB) to secure long-term access to the proposed water supply.

1.2 Existing System Assessment

The City currently provides groundwater from one hundred sixteen (116) active wells located throughout five (5) well fields. For the purposes of this evaluation, the current reliable peak capacity of the system was determined during the Water Master Plan Phase to be 12 MGD. Based on available literature, the reliable annual yield (the average amount that can be pumped annually without depleting the groundwater supply) was determined to be 6 MGD. Though the system is currently producing groundwater in excess of these values, deteriorating mechanical conditions and decreases in the saturated thickness of some wells indicate that the current use is not sustainable.

Groundwater from the wells is transmitted to one of two existing plants, which include storage, chlorination, fluoridation, and pumping facilities. Plant No. 1 (East Pump Station) was determined to have reached the end of its useful life expectancy, and it is proposed that this facility be decommissioned at the completion of the current Program. Plant No. 2 (West Pump Station) was considered to be in good condition, and the existing clearwell and distribution system connections are uniquely located to provide improved groundwater and surface water blending prior to distribution to water consumers. As such, it will continue to be used for the Program.

1.3 Design Criteria

The design criteria section includes a description of the design horizon, population projections, and resulting demand projections for the Program.

1.3.1 Design Period

The first step in determining the design criteria was to establish the design year for the evaluation. Assuming a Program construction completion year of 2022 and a 25-year design horizon for the mechanical systems, as well as other infrastructure that is anticipated to have a useful 25-year life expectancy, results in the year 2047. The remainder of the infrastructure, such as the piping, concrete, and earthen structures, that are anticipated to have a useful life expectancy of 50 years or greater will be designed for the year 2072.

1.3.2 Population and Demand Projections

The City's water demand is proportional to the City's population served. Hence, population projections for the planning horizon were developed in order to create a water demand baseline. The population growth rates for the next 50 years were determined by discussion with City staff, land use analysis, and historic growth rates. For the planning horizon, it is anticipated that the City's service area will continue to grow from an estimated 2010 service population of approximately 48,734 people to a 2080 service population of 70,543.

Historical water use patterns were analyzed to evaluate water demands over the planning horizon. Two baseline scenarios were developed to describe the City's water needs: 1) annual-average daily flow, and 2) maximum-daily flow. Annual-average daily flow is the amount of water the City typically requires on a daily basis over the course of a year. This amount dictates how much annual water supply the City's water resources must yield. Maximum-daily flow is the amount of water the City might use during a high-demand day, but does not represent everyday typical demand. This amount dictates the finished water production capacity the City must be able to produce for its service population. The developed average-day and maximum-day demand curves are presented in Figure 1, and key values are summarized in the following table.

Description	2047	2072
Average Day Demand (MGD)	18.2	19.2
Maximum Month Demand (MGD)	26.0	27.4
Maximum Day Demand (MGD)	33.0	35.0

As described above, the existing reliable peak production capacity of the City's groundwater system is 12 MGD. The projected peak day demand in the design year of 2047 is 33 MGD, which creates a peak day deficit of 21 MGD. As such, the maximum day design flow for all mechanical systems evaluated is considered **21 MGD**. Likewise, the maximum day design flow for the remaining infrastructure evaluated is based on the 2072 demand less the groundwater capacity with buffering provided by the equalization terminal storage reservoir as described later in this Executive Summary.

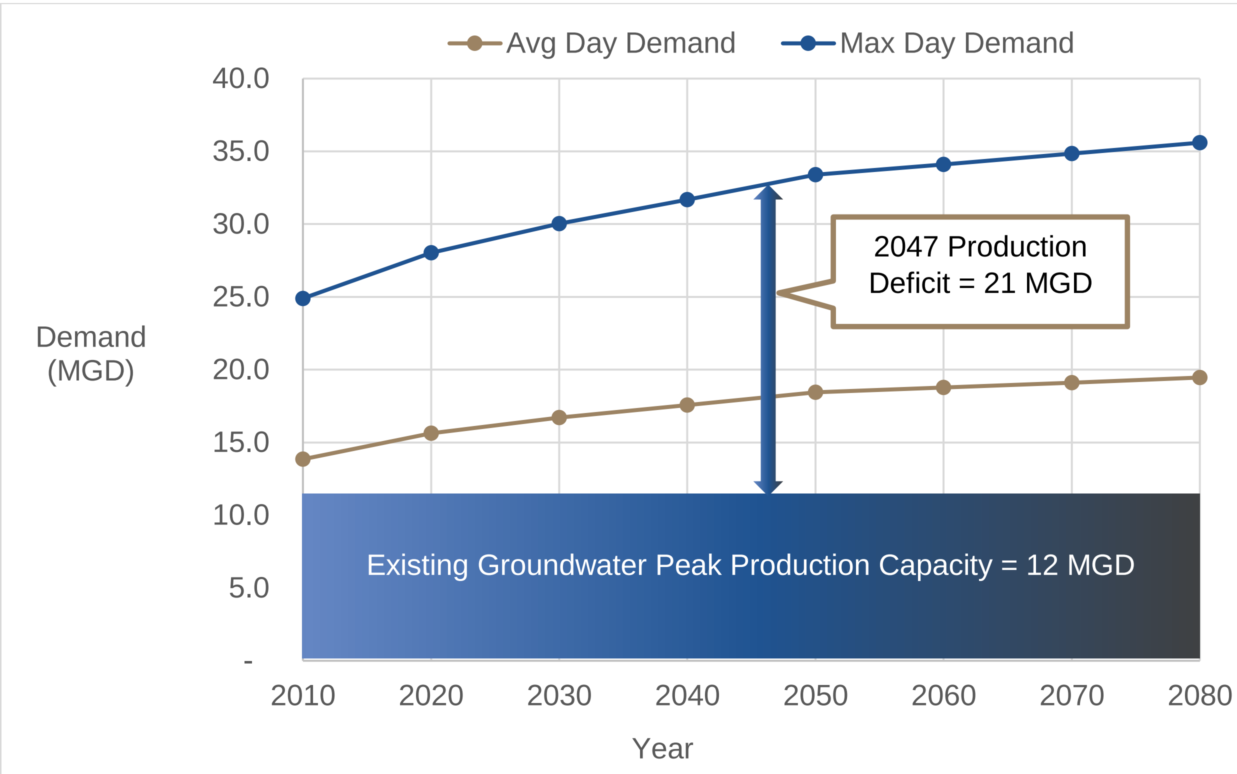

Figure 1: Projected Average and Maximum Day Demand in 2047

1.4 Key Infrastructure

The following sections of this Executive Summary provide a brief overview of the major infrastructure associated with the Kaw Lake Water Supply. More detailed information can be found in the individual Technical Memoranda. The major infrastructure evaluated include:

- Intake and Intermediate Booster Pump Stations
- Pipeline
- Terminal Storage Reservoirs
- Water Treatment Plant
- Distribution

2.0 Intake and Intermediate Booster Pump Stations

The Intake includes the structure and pumping facilities needed to pump water from Kaw Lake to the City of Enid. Major items include the intake structure on Kaw Lake, intake pump station, and the intermediate booster pump station.

2.1 Introduction

An evaluation of alternatives for withdrawing raw water from Kaw Lake was performed. Major elements of the alternatives analysis included:

- Evaluating shared intake use and ownership with partner utilities
- Conducting new intake site selection analysis
- Evaluating raw water pumping alternatives
- Evaluating intake strategies and compliance with USACE permitting requirements
- Conducting preliminary environmental permitting

2.2 Alternatives

The existing Kaw Lake Dam, owned by the USACE, was built with a 48-inch diameter intake pipe penetration into Kaw Lake. This penetration has a single screened inlet and is connected to an underground 48-inch pipeline that runs about 0.5 miles to the south and supplies water to the City of Stillwater's pump station, which provides raw water to the City of Stillwater, Oklahoma. A buried tee located along the pipeline, herein referred to as the "Ponca Tee", was installed as a possible future connection for the nearby City of Ponca City, Oklahoma. There are no other existing intake structures in the body of Kaw Lake for municipal water supply that could be shared in order to supply water to Enid. An evaluation of shared use and new in-lake alternatives was performed to develop a concept for withdrawing raw water from Kaw Lake. The following alternatives were evaluated:

- Shared Use 412 Connection
- Shared Use Ponca Tee
- New Shared Use Enid Tee
- In-Lake Site #1 on the Kaw Lake Dam
- In-Lake Site #2 is on the southwestern shoreline
- In-Lake Site #3 is on the central-western shoreline

2.2.1 In-lake Pumping Sites Selection

Three (3) alternative in-lake intake locations were selected and are shown in Figure 2. These site alternatives were selected based on minimizing pipeline, pumping, and intake construction costs while accessing deep water locations near the original river channel.

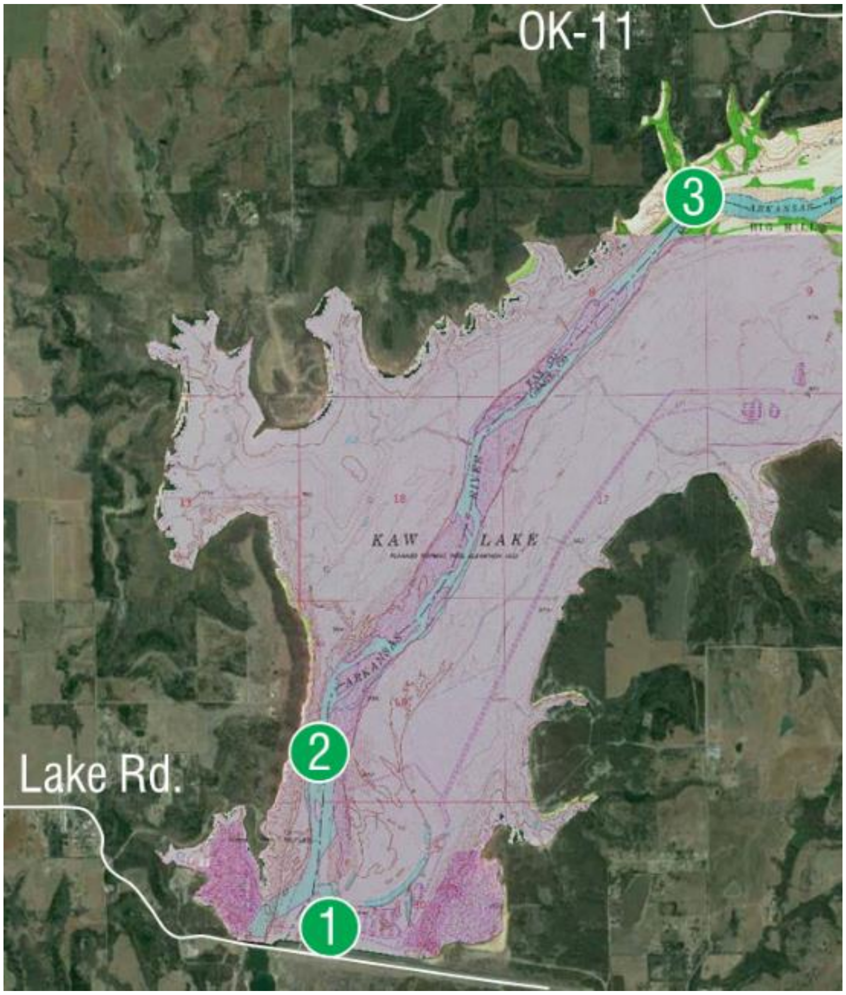

Figure 2: Map of three (3) In-lake Intake Sites Selected

2.2.2 Intake Site Recommendation

After evaluation of the six (6) intake alternatives, In-lake Site 2 was recommended. This recommendation was based on a number of monetary and non-monetary contributing factors as well as discussion with the USACE. A detailed description of each alternative and the specific advantages and disadvantages of each relative to the City if Enid is contained within the Intake and Intermediate Booster Pump Station Technical Memorandum.

2.3 Conceptual Design

The following constraints were used for the general design criteria of the Intake:

1. Pumping Capacity

   a. Maximum = Projected 2047 Maximum Monthly surface water demand of 18.5 MGD (≈12,850 GPM)
   b. Minimum = Current minimum overall system demand of 7.0 MGD (≈4,860 GPM)
2. Lake Level Constraints
   a. Top of Flood Pool Elevation = 1,045'
   b. Normal Pool Elevation = 1,010'
   c. Top of Dead Pool Elevation = 978'
3. Multi-Level Intakes
   a. Minimum of 3 intakes required by ODEQ.
   b. Preliminary Elevations Selected are EL. 1000', EL. 985', and EL. 970'.

The installed elevation of the intake pump discharge heads and motors was selected to be 1,050 feet MSL to ensure that the pump room is sufficiently above the flood elevation of 1,045 feet MSL.

2.3.1 Pumping Capacity

The Intake Pump Station will convey water from Kaw Lake to a Ground Storage Tank (GST) at an Intermediate Booster Pump Station. The Intake design capacity is 18.5 MGD (12,847 GPM). The Intake pump station will be able to turn down speed to meet the City's current system-wide minimum flow rate of 7.0 MGD (4,861 GPM) in order to minimize the number of pumping start-stop cycles. This lower flow is achieved by the use of Variable Frequency Drives (VFDs).

Three (3) 1,250-HP vertical turbine pumps in a parallel configuration are recommended in the conceptual design. The pump station will be configured with two (2) duty pumps and one (1) standby pump.

2.3.2 Intake Pump Station Type Selection

Several types of intake pump stations were evaluated and considered. A major consideration for intake selection and design is that Kaw Lake is already in place, as opposed to a pre-impoundment scenario. The four types of pump station type intakes that were considered were Dredged Channel, Caisson and Microtunnel, Intake Tower and Conduit, and Intake Platform Structure.

2.3.2.1 Recommended Intake Type – Caisson & Microtunnel

The most favorable design considered was the Caisson & Microtunnel concept. Features to this conceptual design include:

- Pump station built on top of hill to be above flood pool elevation
- 40-foot diameter circular caisson wetwell
- 400-foot long, 42-inch diameter microtunnel into lake channel
- Underwater pipe header in lake with three (3) screens and motor actuated valves

A conceptual layout of this concept is shown in Figure 3.

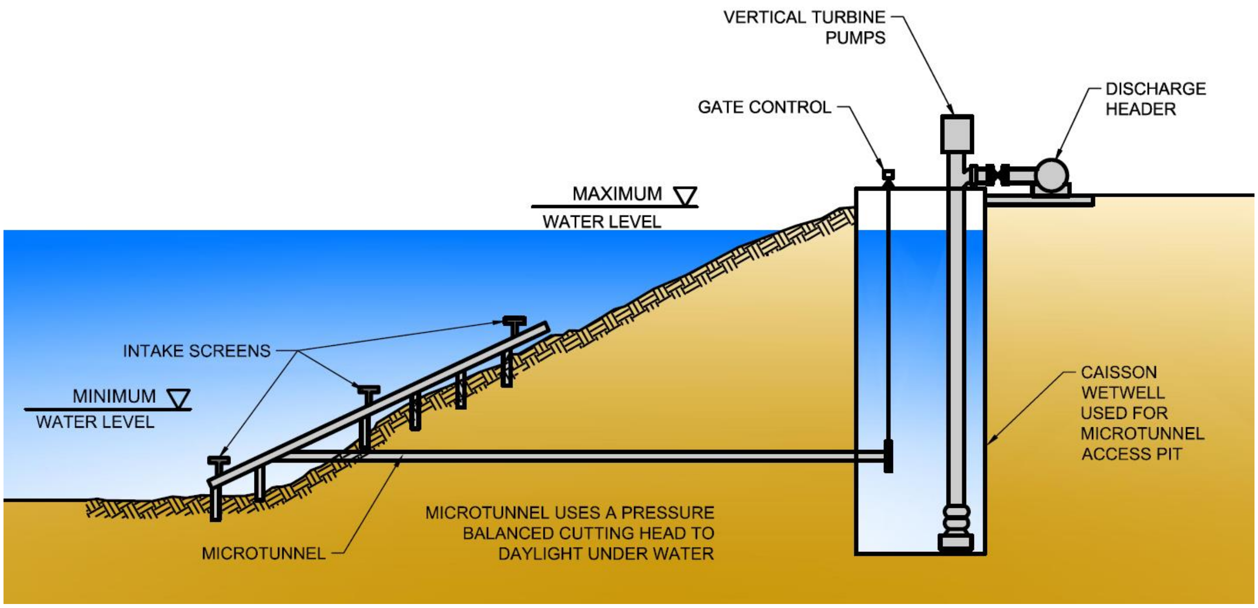

Figure 3: Caisson & Microtunnel Layout

2.3.3 Intermediate Booster Pump Station

An intermediate booster pump station will be needed in order to convey the design flow without providing excessive pressure in the pipeline. Based on system hydraulics, it is intended that the Intermediate Booster Pump Station be located along the pipeline route near State Highway 74.

2.3.3.1 Ground Storage Tank

Conceptual design for the Intermediate Booster Pump Station (BPS) includes a ground storage tank (GST) to provide a stable reservoir on the suction side of the BPS. Based on sizing calculations and the predicted 50-year design flow, the recommended size for the tank is 5 MG.

2.3.3.2 Intermediate BPS Pumping Capacity

The Intermediate BPS pumps will convey water from the GST to a Terminal Storage Reservoir (TSR) adjacent to the new Water Treatment Plant (WTP). This station's design capacity will be 18.5 MGD (12,847 GPM) at 452 feet of head. Like the Intake pump station, the Intermediate BPS will be able to turn down speed to meet the City's current system-wide minimum flow rate of 7.0 MGD (4,861 GPM) in order to minimize the number of pumping start-stop cycles. This lower flow is also achieved by the use of VFDs.

Four (4) 1,000 HP horizontal split-case pumps in a parallel configuration are recommended in the conceptual design. The pump station will be configured with three (3) duty pumps and one (1) standby pump.

2.3.3.3 Intermediate BPS Layout

The Intermediate Booster Pump Station was designed to be an on-grade building with a common suction header, common discharge header, and four parallel horizontal split case pumps. Also included is an overhead door with an overhead crane and monorail. An adjacent air-conditioned electrical room will house VFD's and controls. Outside the main building is the GST, a discharge flowmeter inside a concrete vault, access road, backup generator, and associated buried valves.

2.4 Cost Estimates

Capital costs for the proposed Kaw Lake Intake Pump Station and Intermediate BPS include power transmission, emergency back-up power, access roads, site civil, structural, mechanical, and pump station electrical, as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency. The Rough Order of Magnitude cost estimate for the Intake and Intermediate Booster Pump Station is $49,611,000.

3.0 Pipeline

The pipeline will convey the raw water from the proposed Kaw Lake intake structure to the proposed Water Treatment Plant (WTP).

3.1 Introduction

An analysis of the Kaw Lake Water Supply Pipeline was performed including a corridor evaluation, hydraulic analysis, and capital and life cycle cost estimates. Three (3) corridor options for the proposed raw water pipeline from the Kaw Lake Intake Pump Station to the proposed Enid WTP were evaluated.

3.2 Alternatives

The Direct Corridor is routed diagonally from the proposed intake to the proposed WTP. The Southern Corridor is routed southwest from the proposed intake for approximately 18 miles, then turns west towards Enid near Red Rock. The Northern Corridor is routed west from the proposed intake for approximately 55 miles, then turns south northeast of Enid. Total lengths of each corridor are listed below:

- Direct Corridor – 67.5 miles
- Southern Corridor – 74.0 miles
- Northern Corridor – 78.6 miles

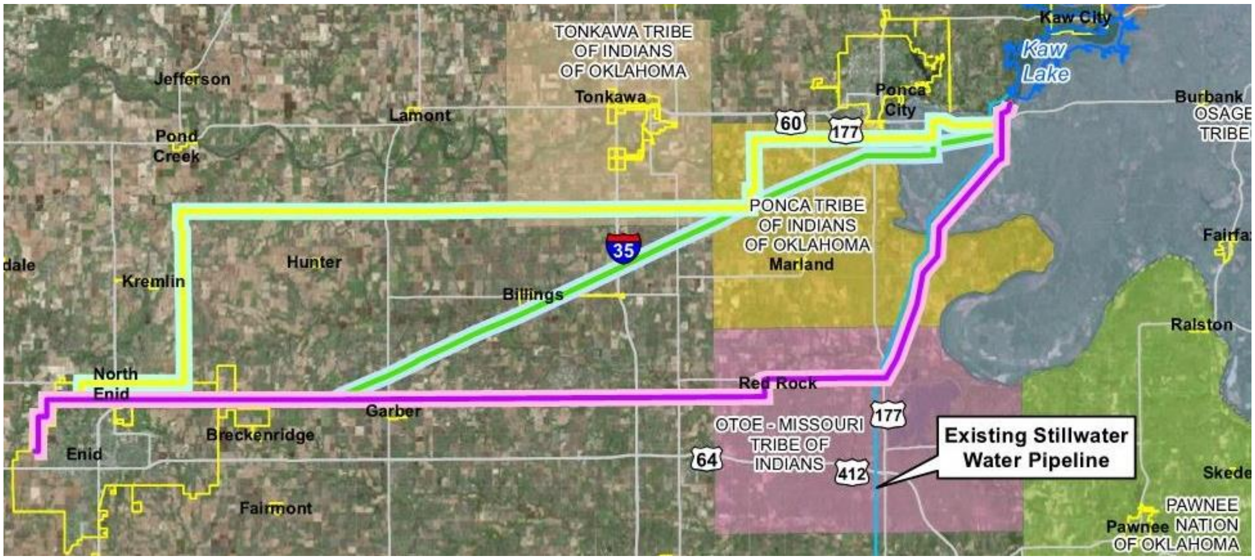

Figure 4: Pipeline Corridor Map

Each of the corridors passes through multiple tribal lands as shown in Figure 4. The Direct and Northern Corridors are routed through the Osage, Ponca, and Tonkawa tribal lands, and the Southern Corridor is routed through the Osage, Ponca, and Otoe-Missouri tribal lands.

The Direct and Northern Corridors provide partnering opportunities with other cities and towns to the north along each corridor. Ponca City and Phillips 66 Ponca City Refinery have expressed interest in partnering with the City of Enid for additional water supply. The Southern Corridor provides a partnering opportunity with the City of Stillwater. At the time of the evaluation, the City of Stillwater encouraged the City of Enid to select a corridor that was best for Enid. The City of Stillwater has its own long-term water supply plan, but may still have a partnering interest as the Program continues to develop.

3.3 Recommended Alternative

Evaluation of the corridors is based on affordability, operation and maintenance, constructability, environmental concerns, construction schedule, landowner impact, and regional use. The Direct Corridor provides the most advantageous alternative for the City of Enid and is the recommended corridor.

3.4 Conceptual Design

The design flow for the Kaw Lake Water Supply Pipeline is 19.5 MGD based on the 2072 max month demand for surface water. A preliminary hydraulic analysis of the Direct Corridor concludes that a 36-inch pipeline or combination of 42-inch and 36-inch pipelines are viable alternatives. Both scenarios will require an intermediate booster pump station to provide the required design flow. A pipeline optimization analysis that compares the capital costs and power (pumping) costs for each diameter results in a recommendation of a 36-inch pipeline. The recommended location of the intermediate booster pump station is just east of State Highway 74 along the Direct Corridor.

3.5 Cost Estimate

Capital costs for the Direct Corridor include the pipeline and installation, fittings and valves, and all site restoration as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency. The Rough Order of Magnitude cost estimate for the Pipeline is $189,020,000.

4.0 Terminal Storage Reservoirs

Terminal storage is employed to provide a constant supply of raw water to the new water treatment plant, and it can also be utilized to minimize costs associated with conveyance of raw water. As such, the main components of the terminal storage assessed for the current project were Emergency Storage and Equalization Storage.

4.1 Introduction

For this program, the City desires to separate the volume dedicated for equalization storage from the volume for emergency storage. Therefore, the terminal storage is divided into two components:

- Equalization (TSR EQ) – storage used on a routine basis to meet peak demands
- Emergency (TSR EM) – storage used only when raw water conveyance is not in service

The Equalization Storage (TSR EQ) will be located adjacent to the new WTP. The Emergency Storage (TSR EM) will be located at a different location along the pipeline corridor. There are many factors that aid in determining the optimum TSR EM location including Vance Air Force Base flight patterns, land availability, and future ancillary uses of the TSR EM (community water feature). As such, the location of the TSR EM has not been finalized at the present time, but has been conceptually sited east of US Highway 81 approximately one-mile from the proposed pipeline corridor.

4.2 Design Criteria

The design horizon for the terminal storage is 50 years. Therefore, sizing is based on 2072 flows. The following design criteria were used for the two (2) storage components:

- Emergency Storage (TSR EM)
  - Duration: 14 days of storage
  - Daily volume: 13.2 MGD, equal to the 2072 average day demand (19.2 MGD) less the sustainable yield of the well field (6.0 MGD)
  - Total Emergency Storage volume: 185 MG
  - Additional storage volume for the dead pool and stormwater volume
  - Approximate total acreage: 65 acres
- Equalization Storage (TSR EQ)
  - Basis: 3-month maximum conveyance capacity
  - Number of days at average day demand: 4.7 days
  - Design average day flow rate: 13.2 MGD
  - Hydraulic inefficiencies (evaporation, treatment plant losses, etc.): 5%
  - Total equalization storage volume: 64.7 MG
  - Additional storage volume for the dead pool and stormwater volume
  - Approximate total acreage: 20 acres

4.3 Conceptual Design

The conceptual design for the terminal storage was completed with the assumptions and components listed in the following table.

Item	TSR EM	TSR EQ
Number of Cells	1	2
Cell Configuration	N/A	Cells in series; smaller first cell to collect sediment. Water is withdrawn from larger second cell for treatment.
Earthwork Approach	Balanced Cut/Fill	Balanced Cut/Fill
Liner	60 mil textured HDPE liner	60 mil textured HDPE liners; soil cement liner on smaller cell to facilitate sediment removal
Bank Stabilization	Soil cement liner at waterline (width of 6 feet)	Full soil cement liner on smaller cell; soil cement liner on side slopes of larger cell

Conveyance Facilities	Adjacent pump station and 36-inch pipeline to raw water pipeline from Kaw Lake	Low-lift pump station and yard piping to convey water to the head of the WTP

4.4 Recommended Alternative

The following terminal storage facilities are recommended:

- New TSR EQ at Chestnut Site sized based on the 3-month maximum flow scenario
- New TSR EM (at site to be determined) sized to provide 14 days of emergency storage at average day flow in excess of the sustainable groundwater supply

4.5 Cost Estimate

Capital costs for the Equalization and Emergency Terminal Storage Reservoirs include the earthwork, piping, liners, bank stabilization, and conveyance facilities, as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency. The Rough Order of Magnitude cost estimate for the Terminal Storage Reservoirs is $64,433,000.

5.0 Water Treatment Plant

Water quality objectives and infrastructure associated with the proposed water treatment plant (WTP) have been developed to a level of detail sufficient to identify the needed components, update the Program's estimated total costs, and progress with the needed permits. Development of the WTP involved close coordination with City staff and officials through meetings and workshops to assure a realistic and representative approach to planning for the City's future water supply and production needs.

5.1 Introduction

Two site alternatives were considered for location of the proposed WTP. The first site is the property associated with the Northern Oklahoma Resource Center of Enid (NORCE), located in the northeast Enid. The second site is the Chestnut Site adjacent to the existing Plant No. 2 in west Enid.

Based on technical feasibility, operational considerations, geographic location, land use compatibility and land acquisition, environmental impact, and relative project costs, the Chestnut Site is recommended for the WTP and equalization terminal storage reservoir (TSR EQ).

5.2 Alternatives

A number of different technologies and treatment configurations were considered at the onset of the Program. Following workshops with City staff, the long list of treatment alternatives was pared to four (4) different feasible alternatives for full consideration.

- Alternative 1 – Conventional WTP with Ozone and Granular Activated Carbon
- Alternative 2 – Lime Softening with Ozone
- Alternative 3 – Microfiltration-Nanofiltration
- Alternative 4 – Conventional WTP with Nanofiltration

5.3 Recommended Alternative

Costs were developed based on preliminary unit process sizes, preliminary layouts, and conceptual alternative configurations for the facilities associated with each alternative. A non-monetary evaluation was also performed including water quality, environmental impacts, and operability. Each criteria was given a weighted score proportional to its importance, as developed in cooperation with City staff. Alternative 1, Conventional WTP with Ozone and Granular Activated Carbon is the recommended alternative for treatment of surface water from Kaw Lake.

5.4 Conceptual Design

The recommended alternative, shown in Figure 5, proposes pre-oxidation with ozone, a conventional coagulation-flocculation-sedimentation-filtration treatment train followed by post-filtration granular activated carbon (GAC) contactors. Ozone is a powerful oxidant that will serve as the primary disinfectant, as well as mitigate taste and odor compounds. The conventional coagulation-flocculation-sedimentation-filtration train meets the requirements of the Surface Water Treatment Rule, which necessitates multiple barriers for the removal of disease causing microbes present in surface waters. The GAC contactors will be designed to remove dissolved organics and taste and odor compounds that remain in the water following filtration.

The sedimentation basins will produce a moderate amount of residual waste that must be further processed prior to ultimate disposal in a landfill. Gravity thickeners are proposed to concentrate the residual stream prior to storage and further concentration in on-site lagoons. Dried solids will periodically be removed from the lagoons and disposed of in the municipal landfill. Additional waste will be generated during backwash of the filters, which contains a higher volume of water but lower concentration of solids. The backwash waste will be stored in surge basins prior to recycling or discharge to the sanitary sewer or permitted receiving stream.

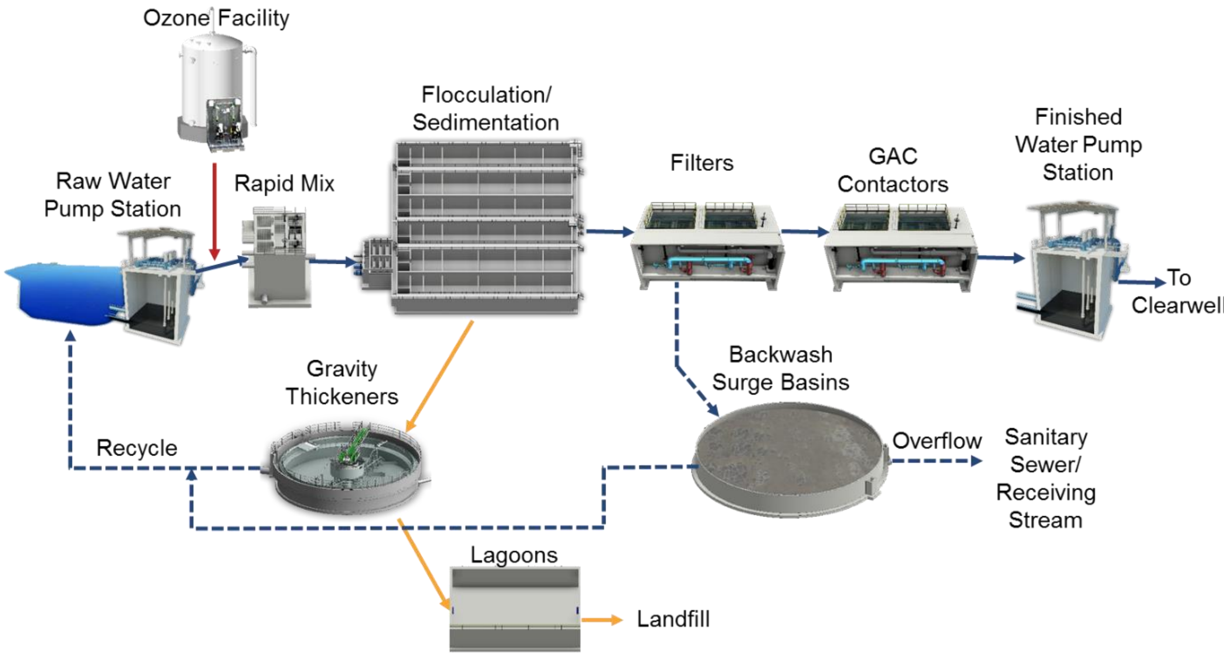

Figure 5: Recommended WTP Alternative Process Flow Diagram

5.5 Cost Estimate

Capital costs for the water treatment plant include the process, structural, mechanical, electrical and civil improvements associated with the recommended alternative, as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency. The Rough Order of Magnitude cost estimate for the WTP is $102,736,000.

6.0 Distribution

Distribution system improvements are necessary to connect water from the new WTP to the existing City of Enid water distribution network. Additionally, improvements necessary to connect, and blend, the existing groundwater supply system to the water distribution network are discussed.

6.1 Introduction

The Enid water distribution network is comprised of two pressure planes, the West (High) and East (Low) Pressure Planes, as shown in Figure 6. The City currently operates two plants, which include storage, chlorination, fluoridation, and pumping facilities. The East Pressure Plane is served by Plant No. 1, which is the older of the two plants.

The West Pressure Plane is served by Plant No. 2. Groundwater is conveyed from the existing well fields to Plants No. 1 and 2.

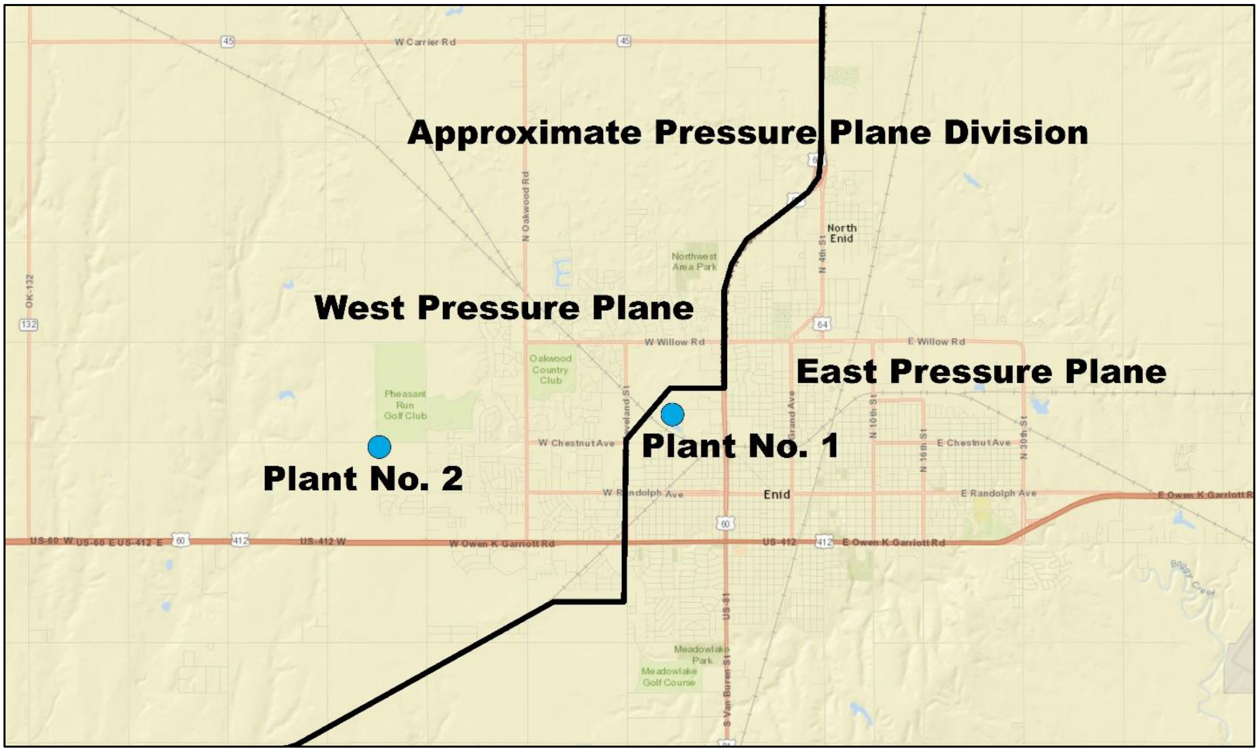

Figure 6: Distribution System Pressure Planes

In general, Plant No. 1 receives water from the Ames, Drummond, and Enid Wellfields, and Plant No. 2 receives water from the Cleo Springs and Ringwood Wellfields. There is an existing connection between the transmission mains to each of the plants, which includes the Imo Pump Station. The City is currently developing a plan outside of this Program that would provide an alternative means of conveyance of water from the Ames and Drummond Wellfields to the proposed WTP site. If this plan is implemented, it would eliminate the need for the Imo Pump Station. Herein, it is assumed that the Imo Pump Station will not be upgraded. If the City does not move forward with plans for the alternative means of conveyance from the Ames Pump Station to the WTP site, then improvements would likely be necessary at the Imo Pump Station.

6.2 Blending

Treated surface water (from Kaw Lake) and groundwater (from the existing well fields) will be blended prior to distribution. Two alternatives were evaluated for blending of the two waters prior to distribution: (1) tank blending and (2) manifold (pipe) blending. The recommended blending strategy for this Program is to blend the treated surface water and groundwater in a pipe prior to entry into a new storage tank. The new storage tank would provide additional volume to facilitate distribution of a uniformly blended water.

6.3 Finished Water Storage

Finished water storage is provided for three main purposes:

- Equalization – storage to meet peak demands (e.g., peak hour demands) in excess of supply capacity
- Emergency – storage in case of emergencies that disrupt raw water production and/or treatment
- Fire – storage to meet peak fire flow demands

Oklahoma Department of Environmental Quality (ODEQ) regulations require storage to meet domestic and fire flow demands, and that a minimum of 24 hours of storage be provided. Required finished water storage volumes were developed based on the following criteria:

- Storage for domestic demands: 24 hours of storage at average day demand
- Storage for fire flow demand: 3,500 gpm for 3 hrs

Following decommissioning of the existing ground storage tanks at Plant No. 1, the total finished water storage for the system will be 12.5 MG. The required volumes is projected to be 19.8 MG in 2072 resulting in a 7.3 MG deficit over the Program design horizon.

Elevated storage serves to reduce peak flow requirements for pumping and conveyance infrastructure. Specifically, sizing elevated storage to provide equalization and fire flow storage reduces the peak flow for pumping and conveyance infrastructure down to maximum day flow. Alternatives for infrastructure sizing for ground storage, elevated storage, and pump station capacity were evaluated, and it was determined that at this stage in the Program the costs were lowest for an alternative that added only ground storage and provided high-service pumping facilities to meet peak hour demands. This recommendation is subject to change based on additional system-specific analysis of diurnal demand patterns and refinement of Program costs.

6.4 Recommended Improvements

The following improvements are recommended for the distribution system to provide required finished water storage, pumping capacity, and connect to existing distribution infrastructure:

- Storage – It is recommended that a new 8-MG ground storage tank be constructed at the Chestnut site, to the west of the existing 10-MG storage tank. The existing ground storage tank will be devoted to groundwater storage and the new ground storage tank will be used for the blended water.
- High-Service Pump Station – A single high-service pump station is recommended with a common wet well that supplies water for a set of pumps for each of the pressure planes

(East and West). The design flow and total dynamic head (TDH) for the East Pump Station are 24,400 gpm and 136 ft TDH, respectively. The design flow and TDH for the West Pump Station are 16,900 gpm and 164 ft TDH, respectively.

- Transmission Main to East PP – A new transmission main is necessary to convey water from the East Pump Station to the East Pressure Plane. The corridor is along Chestnut Ave to connect to the large diameter lines east of the railroad tracks (near existing Plant No. 1). The length of the alignment is approximately 3.5 miles, and it is recommended that a 42-inch pipe be installed.

6.5 Cost Estimate

Capital costs for the distribution improvements include the pumping facilities, ground storage, and transmission main, as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency. The Rough Order of Magnitude cost estimate for the Distribution Improvements is $45,684,000.

7.0 Permitting Strategy

Common federal permits anticipated for the Program include Sections 401, 402, and 404 of the Clean Water Act. Additionally, 408 permission is required prior to the USACE issuing 404 permits and is a major component of the Intake permitting with the USACE. Depending on the extent of the wetland and stream impacts, a Nationwide Permit (NWP) or an Individual Permit (IP) will be required. An application for Permit to Construct Water Pollution Control or Public Water Supply Facilities and/or Supply Potable Water will be required by ODEQ. Agency Clearances are required prior to construction and will be obtained through the NEPA process. A number of other permits/forms associated with public drinking water supplies shall be coordinated with ODEQ. Some of the infrastructure will be located within the FEMA 100-year floodplain, therefore coordination for a no net rise or revisions to FEMA floodplain maps would be required. Overall, there are not any major environmental issues anticipated that would prevent the construction of the proposed facilities.

7.1.1 USACE 408 Process

Kaw Lake Dam and all of the Kaw Lake shoreline is owned by the USACE. USACE Section 408 explains the policy and procedural guidance for processing requests to make alterations to, or temporarily or permanently occupy or use, any USACE project. The 408 permit process will directly impact the intake location selection and must be in place prior to proceeding with the other permits associated with the Clean Water Act, as well as the Real Estate Agreement with the USACE.

8.0 Funding Profile

The combined Rough Order of Magnitude cost estimates for the Program are shown in the table below. As previously stated, this estimate included all of the proposed improvements as well as contractor's overhead and profit, mobilization, land acquisition, Program execution and design, and contingency representing total anticipated Program costs. The total Program costs are as follows:

Facility	Cost
Intake and Intermediate BPS	49,611,000
Raw Water Pipeline	189,020,000
Equalization and Emergency TSRs	64,433,000
Conventional WTP w/ Post-Filtration GAC	102,736,000
Distribution Improvements	45,684,000
Total Rough Order of Magnitude Cost Estimate	**$ 451,484,000**

A funding profile was developed to assist with the financial planning of the program. Each of the infrastructure components were further broken down into its major tasks, including the program management, design and permitting, land acquisition, bidding and construction, and facility start up. The cost for each of these tasks was then applied to the anticipated program schedule to develop the funding profile.

The key assumptions utilized in developing the funding profile are as follows:

- June 2022 target completion date
- All design progresses concurrently
- Multiple construction contracts with independent schedules
- WTP Site purchased ahead of Environmental Clearance
- USACE Contract executed in January 2017
- All spending curves are linear
- Time scale is monthly
- O&M costs are not included

The results are shown in Figure 7.

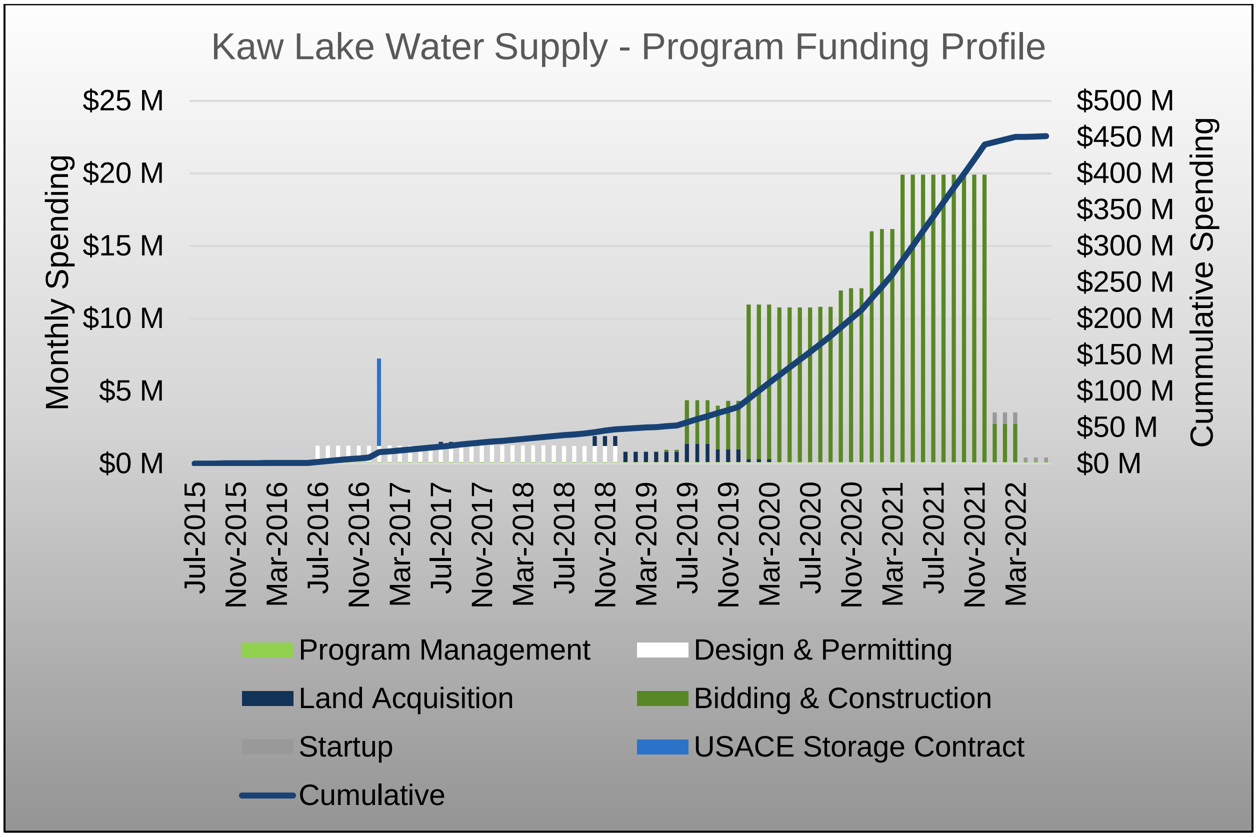

Figure 7: Program Funding Profile

The funding profile was then further analyzed to determine the funding need by fiscal year as shown in Figure 8.

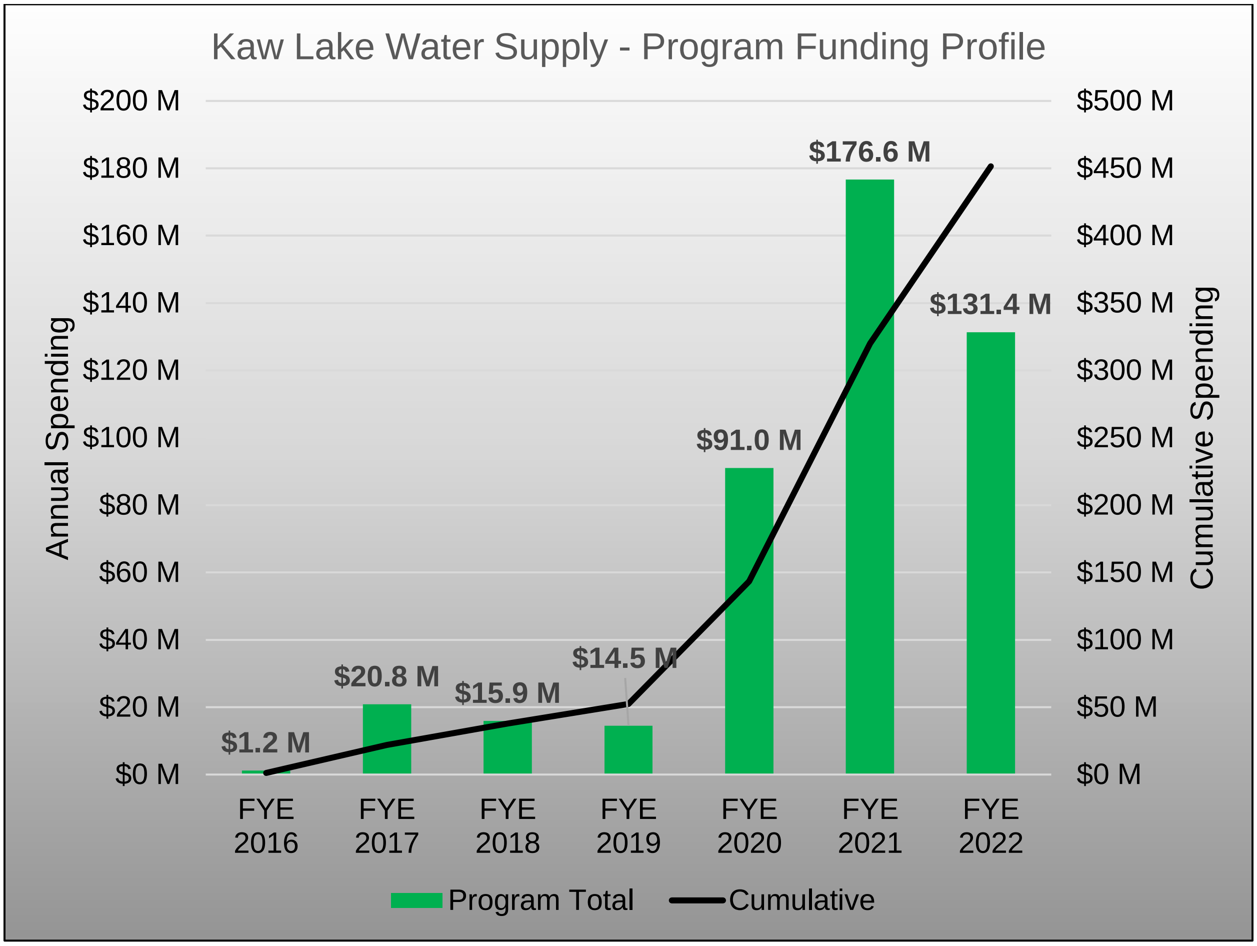

Figure 8: Program Funding Profile by Fiscal Year

9.0 Operations and Maintenance Impacts

Operations and Maintenance Costs (O&M) were developed for the major infrastructure items. The O&M costs presented include the following components:

- Labor
- Chemical
- Energy
- Maintenance
- Transportation

Labor is determined by the man-hours anticipated to operate and inspect the Program infrastructure. Chemical costs are from recent bid prices in the region. The energy base costs are estimated at $0.08/kW-hr. It is assumed that maintenance costs are a percentage of the total construction cost for a new facility generally ranging between 1.0 to 1.5% depending on the item per industry standard. Transportation costs reflect the cost of sludge hauling and disposal typical of other municipalities in the region. The table below summarizes the anticipated O&M costs associated with this Program.

Facility	Annual O&M Cost
Intake and Intermediate BPS	1,931,000
Raw Water Pipeline	3,385,500
Equalization and Emergency TSRs	280,500
Conventional WTP w/ Post-Filtration GAC	4,507,000
Distribution Improvements	586,700
Total Program Annual O&M Cost Estimate	**$ 10,690,700**