Executive Summary (FINAL DRAFT)

This Executive Summary provides an overall summary of the Water Supply System Facility Plan Project. Further detail is presented in the attached Technical Memoranda (TMs). This Summary is organized into the following headings:

- Demand Projections
- Killgore Island Wellfield Modeling
- Water Supply Source Quality
- Identification of Treatment Technologies
- Alternative Wellfield Evaluation
- Management Alternatives
- Distribution System Modeling
- Implementation Plan

The primary purpose of the Facility Plan Project was to determine water supply sources and infrastructure (facilities and equipment) needed to provide a reliable water supply for the City of Kearney through the Year 2015. In addition, consideration has been given to water supply sources beyond 2015.

@ 24mgd
= 647 gpdpc
@ 233 gpdpc =
8.7mgd =
3.2 bgy

Demand Projections

In order to determine needed water sources and infrastructure it was first necessary to estimate future water demands. This work is summarized in the attached TM entitled "Water Demand Projections." Two future demand scenarios were developed; a "high-growth" scenario and a "low-growth" scenario. The high-growth scenario was used to develop and evaluate water supply and management alternatives.

A 2015 population of 37,100 was used, in accordance with projections made by the Kearney Chamber of Commerce. This future population assumes approximately a 1.6-percent annual growth rate. For the purposes of this study, no future service to additional systems outside of the City limits was assumed.

Both peak-day and average future demands were estimated. Peak-day demands are used to size water delivery and treatment systems, and average demands are used to estimate annual energy costs. It was assumed throughout the study that the difference between peak hour and peak day demands will be met through storage within the City.

Historic demands from 1988 through 1994 were used to develop the demand projections. This period of time is believed to be adequately conservative, based upon the fact that 1988 was one of the driest on record, as indicated by the low flows in the Platte River, which are consequences of the Killgore Island Wellfield modeling effort. In order to predict peak demand durations, the following historical periods were examined, encompassing the highest 11 peak-day events during the 1988 - 1994 period:

- Four-month period in 1988
- Four-month period in 1991
- Three-month period in 1990
- Three-month period in 1989

Three-day, 7-day, 14-day, 30-day, and 60-day sustained peaks were calculated in terms of the percentage of the peak-day demand. The most conservative of these percentages are presented in Exhibit 1. For example, if in some future year a peak-day demand of 20 mgd were to occur, it could be expected that the 14-day average demand surrounding this event could be as high as 88 percent of this demand, or 17.6 mgd. This would mean that, on the average, the wellfield would be called upon to supply 17.6 million gallons for each day during that 14-day period.

EXHIBIT 1
Kearney Water Supply Facility Plan
Sustained Peak Water Demands

Averaging Period	Percentage of Peak Day
3-day	98
7-day	95
14-day	88
30-day	78
60-day	67

Future peak-day water demands during non-irrigation season were also estimated, based on historic data from December, January and February of 1988 through 1994. The highest peak-day demand of 4.6 mgd occurred during December, 1989. This demand would be expected to grow to peak day demands of 6.6 and 7.5 mgd for the low-growth and high-growth scenarios, respectively.

Killgore Island Wellfield Modeling

"Sustainable Yields" from the Killgore Island Wellfield under various drought conditions in the Platte River were estimated for the following three wellfield scenarios (the term "Sustainable Yield" is defined later):

- Current situation, with a 21.3-mgd wellfield pumping capacity

Another way to view the historic river flow data is presented in Exhibit 3, which presents the percentage of days during June that various flows are exceeded in the Platte River. For example, taking into account all of the daily flow readings during June since the closure of Kingsley Dam, a flow of 168 cfs was exceeded *90 percent of the time.*

EXHIBIT 3
Kearney Water Supply Facility Plan
June Flow Exceedance Percentages in Platte River

Flow, cfs	*Percentage of June Days That Flow is Exceeded*
14	100
72	95
168	90
340	75
928	50
4,730	25
12,800	10

Based upon a review of the historic data, and a consideration of the City's water supply goals, the following flow-flow events were modeled:

- "Worst-case" drought condition: 50 cfs average for 30 days
- "Moderate" drought condition: *600 cfs average for 120 days*
- *"High" drought condition:* 1,000 and 1,200 cfs average for 120 days

The "worst-case" drought flow of 50 cfs is equal to the worst 14-day June drought on record, is exceeded more than 95 percent of the time in June, and *is close to the City's* projected 2015 peak-day demand of 30 mgd (46 cfs). The "moderate" drought flow of 600 cfs is approximately equal to the worst 60-day June drought on record, *and is exceeded* approximately 60 percent of the time in June. The "high" drought flows of 1,000 and 1,200 cfs are equal to two "maintenance" flows that were being considered at the time the modeling was done, and are exceeded about 50 percent of the time in June.

z- how derived

Peak Water Demands

To allow an assessment of the ability of Killgore Island to supply water, the drought *conditions described above* must be combined with peak water demand conditions. Based on the peak-day demand projections and sustained percentages presented previously, *Exhibit 4 presents* demand / duration conditions which must be met.

5

A close examination of the pattern of wells dropping out of service in Exhibit 5 and other runs revealed that the 1983 wells were always the first to drop out. This is due to the fact that these wells have a higher capacity than the 1992 or future wells (1,500 versus 1,000 gpm) and that the 1983 wells have higher well screen top elevations than the other wells. The results of the preliminary modeling runs suggested that better performance could be obtained during drought conditions if the 1983 wells were replaced by wells similar to the 1992 wells.

Refined Modeling Runs

Following examination of the preliminary modeling runs, the following changes were made for subsequent runs:

- Based on water surface elevation data in the Platte River, provided by USGS, the model was adjusted so that the elevation in the North Channel (north of Killgore Island) is always 0.8 feet lower than the elevation in the Middle Channel (south of Killgore Island), and the South Channel (the main channel in the vicinity of Killgore Island).
- The 1983 wells were replaced with 1,000-gpm wells with well screen elevations equal to the 1992 wells.
- Three additional 1,000-gpm wells were added to replace capacity lost with the smaller-capacity 1983 wells.
- The runs were focused on an expanded nominal pumping capacity of 30 mgd, and river flows of 50, 600 and 1,000 cfs. Six additional 1,000-gpm wells were added to reach a pumping capacity of 30 mgd.

The sustainable yield estimates from the refined runs are summarized in Exhibit 6. As shown in the footnote to Exhibit 6, the sustainable yield estimate for a river flow of 50 cfs is even lower when it is assumed that the river depth in the North Channel is zero. During the severe drought of 1988, it was observed that there was no visible flow in the North Channel at Kearney-gauge flows less than approximately 300 cfs. Thus, the 50-cfs condition was modeled again with this assumption. It was further observed that flows needed to be greater than 600 cfs or so before flow in the North Channel returned; however, as stated previously, the declining-flow portion of droughts was assumed to be worst-case. It is important to note that the disappearance of flow on the north side of Killgore Island was not seen again in 1997, when river flows again dropped below 300 cfs. Changes in river bottom elevations are likely responsible for this inconsistency.

Exhibits 7, 8, and 9 present complete outputs from the refined modeling runs. These outputs present a more realistic view of actual conditions that must be met because they also illustrate water demands. For example, in Exhibit 7 it can be seen that the peak-day, peak-3-day, peak-7-day, and peak-14-day water demands can be met with 50 cfs in the Platte River. This conclusion is drawn by comparing the area under the demand / duration rectangles (equal to total demand volume over the period in question) with the area under the wellfield supply curve (equal to the total volume of water that the wellfield is capable of supplying. As long as the supply curve stays consistently above the demand rectangles, it can be concluded that the demand scenario can be met.

Exhibit 9 presents the projected situation for a river flow of 1,000 cfs, which was also assumed to last for 120 days. As with 600 cfs, all volume conditions are met. The potential shortfall associated with a peak-day demand of 30 mgd occurring on the 120th day is reduced to only 5.8 mgd.

Modeling Conclusions

Based upon the results of the modeling effort, it was concluded that a redundant water supply for the City of Kearney should be considered, to meet potential delivery shortfalls during droughts. Other advantages to a redundant supply are discussed later, but include a guard against the catastrophic failure of Killgore Island, and the potential ability to blend water with the Killgore Island supply for regulatory compliance. A logical capacity for such a redundant supply would be 7.5 mgd, which is equal to the 2015 non-irrigation, peak-day demand under the high-growth scenario. If a 7.5-mgd redundant water supply were provided, the City's water customers would be essentially assured of always having enough water to meet domestic, commercial and industrial needs. Only irrigation would need to be curtailed in the event of the Killgore Island supply being totally lost. With the Killgore Island supply in place, peak water demands including irrigation could be met under a 50-cfs, 30-day drought in the Platte River.

Supply Alternatives

Based on the conclusions presented above, it was determined that a redundant water supply would be appropriate for Kearney. The following five water supply alternatives were identified for subsequent evaluation:

- Killgore Island, plus deep redundant wells at "Location No. 1".
- Killgore Island, plus deep redundant wells at "Location No. 2".
- Killgore Island at 10 mgd (1/3 of the City's demand), plus deep wells at "Location No. 2" at 20 mgd (2/3 of the City's demand).
- Replace Killgore Island entirely with deep wells at Location No. 2.
- Replace Killgore Island entirely with deep wells at Location No. 1.

As discussed later, Location Nos. 1 and 2 are two potential deep-well locations near the City. No. 1 is in a general area having high transmissivity and high nitrate concentrations. No. 2 is in a general area having low transmissivity and low nitrate concentrations.

a redundant, not extra!

Water Supply Source Quality

Of equal importance to providing an adequate quantity of water is the requirement to meet various quality requirements, which are outlined in regulations developed by EPA under the authority of the Safe Drinking Water Act (SDWA). Water quality data for both Killgore Island water and deep wells were thoroughly reviewed. Details are presented in the attached TM entitled "Water Supply Source Quality."

this to 80 ppb. Several years in the future, the Stage 2 limit could be set as low as 40 ppb. The TTHM concentration consists of the sum of four compounds: chloroform, bromodichloromethane, chlorodibromomethane, and bromoform.

TTHM compliance was examined in two different ways. First, formation potential (THMFP) tests were performed in the laboratory by adding chlorine and allowing the sample to sit for 48 hours, with TTHM concentrations being measured at 1, 24 and 48 hours. Second, TTHM concentrations have been measured in the City's distribution system. An example of the first approach was conducted in April, 1997. TTHM concentrations were found to be 35, 102, and 139 ppb after 1, 24 and 48 hours, respectively. The City's water is somewhat unusual in that the predominant fraction of the TTHM concentration is made up of brominated compounds rather than chloroform. This is due to the presence of naturally occurring bromide in the water. TTHM concentrations in the distribution system, on the other hand, have never been seen higher than 61 ppb. For example, in a sample taken in Windy Hills in May, 1997, the TTHM concentration was 33 ppb. Compliance with the D/DBP Rule is based upon quarterly averages, and it is recommended that the City continue to collect quarterly data in the distribution system.

Another type of disinfection byproduct that will be regulated under the Stage 1 and 2 D/DBP Rule is Haloacetic Acids (HAAs). The Stage 1 limit is expected to be 60 ppb, and the Stage 2 limit could be as low as 30 ppb. Available data indicate that HAA concentrations are below the Stage 1 and Stage 2 limits in the distribution system (maximum of 16 ppb); however, it is recommended that the City collect quarterly data for HAAs as well as TTHM.

- Enhanced Surface Water Treatment Rule: EPA is currently collecting data under the Information Collection Rule (ICR), which will be used to create future regulations under the ESWTR. One of the primary purposes of the ESWTR will be to ensure that drinking water customers are protected against *Cryptosporidium*; however, it is uncertain what form the final ESWTR will take; however, it is possible that specific removal / inactivation requirements for *Cryptosporidium* will be included in the ESWTR. Inactivation of *Cryptosporidium* requires a stronger disinfectant than chlorine, such as ozone or chlorine dioxide.

  An Interim ESWTR (IESWTR), which is expected to be issued in 1998, will lower the maximum allowed turbidity levels from the current 0.5 NTU in 95 percent of all samples to 0.3 NTU in 95 percent. The turbidity is the City's finished water is much lower than 0.3 NTU; therefore, compliance with the IESWTR should not be a problem.

Deep Wells From Ogallala Aquifer

A review of data from deep wells revealed the following potential concerns regarding present and future SDWA compliance:

- Nitrate: Concentrations of nitrate at Location No. 1 exceed the current MCL of 10 mg/l. Concentrations at Location No. 2, on the other hand, are below 10 mg/l.

- Arsenic: Concentrations up to 8 ppb have been measured. This complies with the current MCL of 50 ppb; however, EPA is planning to lower this to between 2 and 20 removed through the addition of sulfur dioxide, which reduces it to chloride while oxidizing sulfite to sulfate. Chlorate is another byproduct of chlorine dioxide, which will also be regulated in the future. Piloting would also be needed before chlorine dioxide would be recommended for use.

Ogallala Deep Wells

A baseline level of treatment was also assumed for the deep wells, consisting of the following:

- Phosphoric acid addition for corrosion control (assumed to be needed since a corrosion study has not been performed).
- Hypochlorite for disinfection.
- Ammonia for quenching of free chlorine.

Since TOC levels are low in deep well water, it is doubtful that ammonia quenching will be needed.

Exhibit 11 summarizes treatment techniques for the deep well compliance challenges. The treatment techniques presented in Exhibits 10 and 11 were combined with supply alternatives to create management alternatives, as discussed later.

EXHIBIT 10
Kearney Water System Facility Plan
Treatment Techniques for Killgore Island Compliance Challenges

Treatment Technique	Compliance Challenges Met	Comments
Ion Exchange	Proposed uranium MCL	This approach would only be used for uranium removal alone. Compliance might also be achieved through blending with deep water from Location No. 2.
Coagulation / Filtration	ESWTR (removal), Stage 2 DBP Rule, Proposed uranium MCL	The ESWTR might require additional removal of *Giardia*, viruses, or *Cryptosporidium*. Compliance with the Stage 2 DBP Rule might require removal of TOC through filtration. Uranium removal could also be accomplished. The potential additional pathogen removal requirements under the ESWTR might be met through natural filtration. Stage 2 DBP Rule might be complied with using ammonia quenching alone, or could be met by using an alternative primary disinfectant such as chlorine

EXHIBIT 11
Kearney Water System Facility Plan
Treatment Techniques for Deep Well Compliance Challenges

Treatment Technique	Compliance Challenge Met	Comments
		Location No. 1 only.
Ion exchange & coagulation / microfiltration	Arsenic and nitrate	Removal of both arsenic and nitrate might be needed at Location No. 1, depending on the final outcome of the Arsenic Rule.

Alternative Wellfield Evaluation

To allow costs for deep well supplies to be estimated, the geo-hydrology of the Ogallala Aquifer in the vicinity of Kearney was examined. This allowed the number and capacities of wells to be estimated. The following two deep well areas were examined:

- Location No. 1: High transmissivity, high levels of nitrate.
- Location No. 2: Low transmissivity, low levels of nitrate.

As presented earlier, deep wells could be used to either supplement the Killgore Island wellfield, or to replace it. In the first case, "supplemental" wells would be required to provide a high capacity (7.5 mgd total) for a short duration. In this case, the groundwater levels would be allowed to drop, followed by recovery when pumping stops. In the second case, "replacement" wells would be required to provide a continuous supply without lowering the groundwater table.

For the supplemental wells, the following number and capacity were established. Further details are presented in the attached TM entitled "Kearney Alternative Wellfield Evaluation."

- Location No. 1: 3 wells, with 2 pumping at 2,625 gpm each
- Location No. 2: 9 wells, with 8 pumping at 660 gpm each.

For the replacement wells, the following number and capacity were established to provide a capacity of 30 mgd. Further details are presented in the same TM. The overall assumption was made that half of the wells would pump for 6 months, and all of the wells would pump for the other 6 months.

- Location No. 1: 14 wells, with 12 pumping at 1,750 gpm each. Spacing between each set of pumps would be 1,500 feet, resulting in a total distance of 3.7 miles.

EXHIBIT 12
Kearney Water Supply Facility Plan
Water Supply Alternatives

Supply Alternative	Killgore Island Supply, Peak Day Capacity (mgd)	Deep Well Supply, Peak Day Capacity/Location (mgd)	Features
			each at Location No. 2.
#4	0	30 / Location No. 1 7.5 / Location No. 2	14 wells at 1,750 gpm each at Location No. 2. 9 wells at 660 gpm each at Location No. 1.
#5	0	7.5 / Location No. 1 30 / Location No. 2	40 wells at 600 gpm each at Location No. 2. 3 wells at 2,625 gpm each at Location No. 1.

Capital, O&M, and present worth costs were developed for 40 management alternatives. Each alternative was given a "code" number, such as the following:

1A + 9D (#2)

This particular code number can be described as follows:

Killgore Island with baseline treatment ("1") at 30 mgd peak day capacity ("A")

+

Deep wells at Location No. 2 with baseline treatment and coagulation / microfiltration ("9") at 7.5 mgd peak day capacity ("D")

(Water Supply Alternative #2)

All of the individual management alternatives are listed later in Exhibits 13 and 14.

Overall, numbers 1 through 11 identify the water supply source and the treatment techniques, as follows:

1. Killgore Island with baseline treatment
2. Killgore Island with baseline and ion exchange treatment
3. Killgore Island with baseline and ozone treatment
4. Not used (originally used for an atrazine removal process; however, atrazine was later determined to not be an item of significant concern).
5. Killgore Island with baseline and coagulation/filtration treatment
6. Killgore Island with baseline and ozone / ion exchange treatment
7. Killgore Island with ozone / coagulation/filtration treatment

baseline deep well treatment, the present worth cost of #3 is up to 15 % lower than that for #2.

EXHIBIT 13
Kearney Water Supply Facility Plan
Management Alternative Evaluation Results, Including Baseline Treatment for Deep Wells (and nitrate removal for Location No. 1)

#2 Alternatives	#1 Alternatives, % Greater Than #2 Alternatives	#5 Alternatives, % Greater Than #2 Alternatives	#4 Alternatives, % Greater Than #2 Alternatives	#3 Alternatives, % Greater Than #2 Alternatives
1A + 8D	3% (1A + 10D)	105% (8A - 10D)	69% (10A + 8D)	27% (1C + 8B)
2A + 8D	2% (2A + 10D)	60% (8A + 10D)	31% (10A + 8D)	8% (2C + 8B)
3A + 8D	2% (3A + 10D)	51% (8A + 10D)	24% (10A + 8D)	4% (3C + 8B)
5A + 8D	2% (5A + 10D)	47% (8A + 10D)	21% (10A + 8D)	3% (5C + 8B)
6A + 8D	2% (6A + 10D)	26% (8A + 10D)	4% (10A + 8D)	-6% (6C + 8B)
7A + 8D	1% (7A + 10D)	6% (8A + 10D)	-13% (10A + 8D)	-15% (7C + 8B)

Where: Numbers 1 through 8 refer to levels of treatment at Killgore Island, Numbers 8 and 9 refer to levels of treatment at Location No. 2 deep wells, and Number 10 and 11 refer to levels of treatment at Location No. 1 deep wells. Letters A through D refer to peak day capacities of 30, 20, 10, and 7.5 mgd, respectively. Numbers #1 through #5 refer to water supply alternatives presented in Exhibit 12. Percentages are based on present worth costs.

EXHIBIT 14
Kearney Water Supply Facility Plan
Management Alternative Evaluation Results, Including Baseline Treatment (and nitrate removal for Location No. 1) and Arsenic Removal for all Deep Wells

#2 Alternatives	#1 Alternatives, % Greater Than #2 Alternatives	#5 Alternatives, % Greater Than #2 Alternatives	#4 Alternatives, % Greater Than #2 Alternatives	#3 Alternatives, % Greater Than #2 Alternatives
1A +9D	1% (1A + 11D)	150% (9A + 11D)	120% (11A + 9D)	48% (1C + 9B)
2A + 9D	1% (2A + 11D)	105% (9A + 11D)	81% (11A + 9D)	28% (2C + 9B)
3A + 9D	1% (3A + 11D)	95% (9A + 11D)	72% (11A + 9D)	25% (3C + 9B)
5A + 9D	1% (4A + 11D)	91% (9A + 11D)	69% (11A + 9D)	23% (5C + 9B)
6A + 9D	1% (6A + 11D)	68% (9A + 11D)	48% (11A + 9D)	13% (6C + 9B)
7A + 9D	1% (7A + 11D)	45% (9A + 11D)	27% (11A + 9D)	3% (7C + 9B)

Where: Numbers 1 through 8 refer to levels of treatment at Killgore Island, Numbers 8 and 9 refer to levels of treatment at Location No. 2 deep wells, and Number 10 and 11 refer to levels of treatment at Location No. 1 deep wells. Letters A through D refer to peak day capacities of 30, 20, 10, and 7.5 mgd, respectively. Numbers #1 through #5 refer to water supply alternatives presented in Exhibit 13. Percentages refer to present worth costs.

a. Feasibility of Single Pressure System vs. Existing Pressure System

This portion of the Water Supply System Facility Plan Project focused on the distribution system to determine the adequacy of facilities and to investigate the feasibility of an alternate mode of operation of the distribution system. The distribution study was initiated to analyze existing facilities for the purposes of planning to the year 2015. During the study a distribution system model was developed for use by City personnel.

System Modeling

CYBERNET by Heastad Methods was the selected model used for the study. Development of the distribution system model involved the compilation of numerous data such as water main diameter, length of water main, elevations, demand factors, field tested static elevations and storage facility elevations. This information was entered into the framework of the model. The model utilizes this data to simulate actual conditions within the distribution system. Once this data was calibrated in the model, various hypothetical conditions such as fire flows which can stress the distribution system may be simulated. When the model simulates a stressed system, weak components or deficiencies can be identified. The model can also be a useful tool to determine the needs of the system when potential new water main developments are desired.

Model-Developed Recommendations

During development of the distribution system model, a number of field tests were performed on the distribution system. Development of the model involved monitoring static system pressures and flow testing selected fire hydrants. This testing and City personnel interviews helped to identify areas of low pressure and low flows within the physical distribution system. The areas of low flows in the low service area are generally near the central location of the City where the oldest piping is located. Low pressure areas in the high service area generally exist at ground elevations equal to the base of the elevated towers. The low flow areas are created in part by small diameter aging water main which are corroded and improperly looped (small diameter pipe serving an large area with inadequate feeder lines).

A task associated with the development of the distribution system model was the consideration of an alternate mode of operation for the water system. This alternate operation mode considered the possibility of operating the system as a single pressure system instead of the existing two pressure system. Existing design criteria of the well field pumps would allow operation of the distribution system in the proposed single pressure operation mode. The recommendation of single pressure operation of the distribution system is discussed later in this executive summary.

Proposed Distribution System Operation

It is recommended that the distribution system be operated as a single pressure system instead of the current two pressure system mode of operation. This mode of operation was briefly tested on a trial basis on March 12, 1997. The trial was completed without water main breaks in the City distribution system. Several service main calls were experienced

Should the City continue the current two pressure system mode of operation, the proposed storage requirement would be the construction of 1 MG of additional storage for the low pressure system and 2 MG of additional storage for the high pressure system.

Design Guidelines - Water Main and Sewer Main Design

Guidelines developed for this facility plan are the first step to standardize design practices for both the water distribution system and the sewer collection system for the City. These guidelines provide an initial framework for underground main development within or near the City of Kearney. The guidelines were created to not only provide the City with standard practices, but to initiate a review system to allow alternate designs. Standards of the Nebraska Department of Health and Human Services and the Nebraska Department of Environmental Quality were used as a major basis for these guidelines.

Implementation Plan

In order to implement the selected plan, the actions presented in Exhibits 15 and 16 must take place. Further detail is provided in the attached TM entitled "Implementation Plan." The costs in Exhibits 15 and 16 are construction costs, and do not include legal, engineering, administration and contingency costs.

EXHIBIT 15
Kearney Water Supply Facility Plan
Implementation Plan for Supply System

Required Action	Approximate Construction Cost (S 1997)
Add phosphoric acid and ammonia fee capabilities to the chlorine building recently completed.	Phosphoric acid: $50,000 Ammonia: $50,000
Replace 1983 wells with 1,000-gpm wells with lower well screens.	$2,000,000*
Add 3 1,000-gpm wells to replace capacity.	$1,000,000
Install 6 new 1,000-gpm wells to get 30 mgd	$2,300,000
Install 9 deep wells at Location No. 2, with transmission line into the City.	Wells: $4,900,000 Line: $2,600,000
Improve reliability of electrical feed to Killgore Island.	Unknown, but believed to be minimal.
Continue to sample for compliance with SWTR, as required by NDOH.	$0
Meet future regulations as needed.	Depends on future regulations.

* Alternatively, the existing pump could be replaced and the existing well

Exhibit 17 illustrates a proposed schedule for the required actions. The tasks in this exhibit are listed in approximate order of priority, as determined by City staff. Exhibit 17 does not list the following items which are included in Exhibits 15 and 16; approximate timings for these items are also given below:

- Add phosphoric acid feed system when instructed to do so by NDOH (1998 at earliest).
- Add ammonia feed system when needed for compliance with Stage 1 or 2 DBP Rule (1999 at the earliest).
- Continue to sample for compliance with SWTR throughout at least 1998.
- Meet future EPA regulations; timing to be determined by the future regulations themselves.
- Eliminate ground storage facilities in approximately 2003.
- Eliminate Booster Pump Stations #1, #2, #3, #4 in approximately 2003.

Further discussion is presented below.

At the present time, NDOH is not aggressively enforcing the requirements of the Lead & Copper Rule; however, this may change in the near future. As soon as the situation does change, the City should run a pilot test of phosphoric acid addition, as recommended in the Corrosion Study, and then install permanent feed facilities at the new Chlorine Building if the test is successful.

With the recent completion of the Chlorine Building, chlorine dosage control is closer to optimum than in the past. The City should monitor THMs in the distribution system for comparison with the Stage 1 DBP Rule. If compliance with the Stage 1 Rule is not being consistently met, ammonia feed facilities should be added.

The 1983 wells should gradually be replaced by 1,000-gpm wells with lower well screens. As an interim step, liners could be placed within the existing casings to lower the screens, along with replacement of the existing pumps. Eventually, however, new casings will probably be needed because the lives of the existing screens could be shortened. New wells will be needed to replace capacity that is lost through the replacement of the 1,500-gpm 1983 wells with 1,000-gpm wells. In addition, more wells will be needed over time to achieve a wellfield capacity of 30 mgd. Regarding the additional capacity, the City should investigate the possibility of locating the new wells on the island to the south of the existing wellfield, which has recently been purchased by the Nature Conservancy. This organization has expressed some interest in talking with the City, and this location would have some advantages; for example, the wellfield capacity would be spread out more perpendicular to the river, which would be better for capturing river water recharge.

The CT calculations referenced above were performed using actual daily pH and temperature data 1996. Using a demand of 30 mgd for every day from May 1 through September 30, and an assumed chlorine residual of 1 mg/l, percentages of the transmission line distance from the wellfield to the first customer needed to achieve the required 1-log inactivation of *Giardia* were calculated. It was found that a maximum of 69 percent of the 30-inch transmission line length to the first existing customer would be needed.

The City should carefully monitor progress on new regulations and respond accordingly. In addition to the required actions presented in Exhibit 15, it is important to realize that the following actions might need to be taken in response to regulatory changes:

- Installation of ion exchange treatment at Killgore Island to meet proposed uranium MCL.
- Installation of arsenic treatment at Location No. 2 to comply with future Arsenic Rule.
- Installation of coagulation / filtration at Killgore Island to comply with the future ESWTR, and/or Stage 2 DBP Rule. Uranium removal could also be provided as a side benefit of filtration, eliminating the need for ion exchange.
- Installation of ozone or chlorine dioxide as the primary disinfectant to comply with the future ESWTR and/or Stage 2 DBP Rule.

If it becomes necessary to install additional treatment at either Killgore Island or Location No. 1, the City should investigate the potential use of aquifer storage and recovery (ASR). An ASR system would consist of injection/recovery wells which would inject treated water into the ground for storage during periods of low demand, followed by recovery of the water during periods of high demand. The primary advantage of this approach is that the treatment system could be constructed with a capacity much less than peak day, which could potentially save a significant amount of money. The cost of an ASR system would need to be compared with the savings in treatment.

If the requirement to remove uranium is imposed before the ESWTR and Stage 2 DBP Rule are finalized, which is expected, the City should ask NDOH for an implementation schedule that would not result in construction of ion exchange for uranium removal, only to find out later that filtration is required for the other rules. As discussed previously, filtration will also remove uranium, which would make the ion exchange process unnecessary. Alternatively, the City could potentially build a pipeline from Location No. 2 to Killgore Island for blending. The water from Location No. 2 has a much lower uranium concentration.

Consideration has also been given to water supply sources after the year 2015. At this point, the most feasible approach appears to be to increase the capacities in the Killgore Island vicinity and Location No. 2 proportionally as the peak day demand increase. The "Killgore Island vicinity" is intended to mean either the Killgore Island wellfield, the island to the south of Killgore, or deep wells south of the Platte River.

This study of the distribution system represents an effort to plan for future needs, while updating the present distribution system. The planning horizon of this study is the year 2015. The proposed improvements will benefit and upgrade the distribution system and will improve water service to individual homeowners. Improving fire protection and pressure improvements were two primary concerns for this distribution system study. Varied analysis were utilized to determine these needs. The steps taken to create the distribution model assisted in delineation of needed improvements. It should be noted, continued fire hydrant testing by the City at various locations could identify additional required improvements. The scope of this study did not allow testing of numerous individual fire hydrants to delineate all potential problem locations in the City. The proposed improvements will however, benefit a large portion of the City and will help to

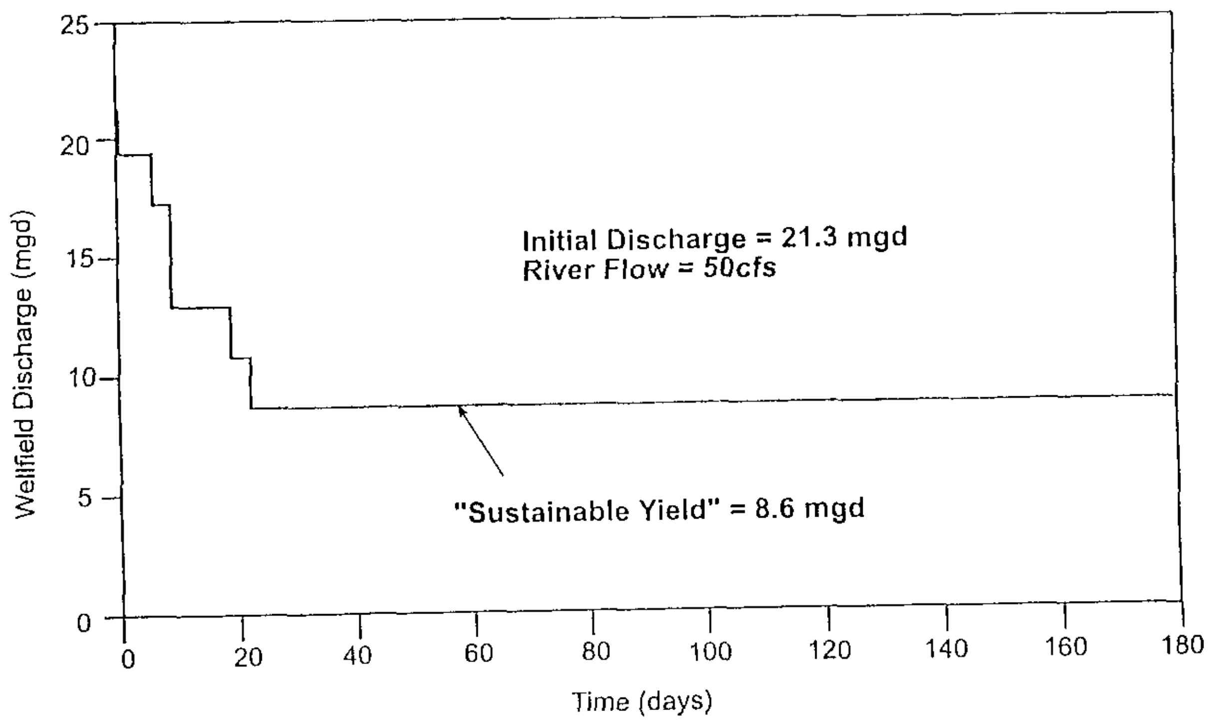

Exhibit 5
Typical Model Output Graph

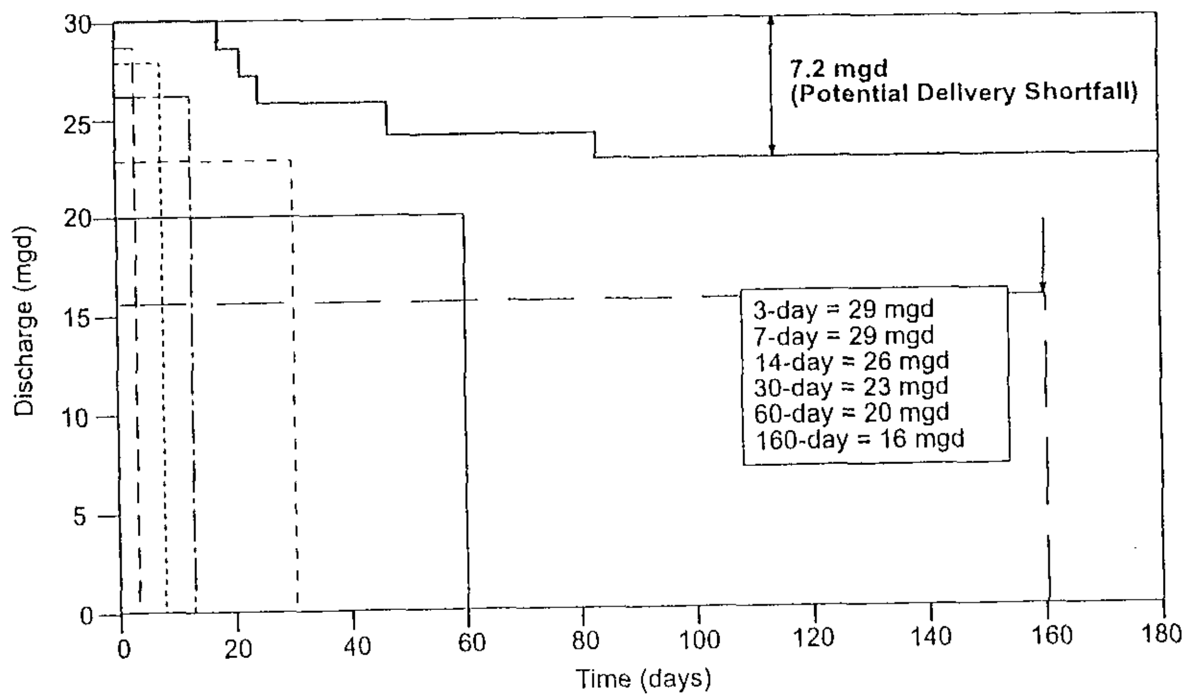

Exhibit 8
Model Output for 120-Day Drought at 600 cfs River Flow

Task No.	Task Name	Planned Start	Planned Finish
1	**Eliminate 250,000 Gallon Water Tower**	1/5/98	7/31/98
1.1	Design Removal Requirements/Receive Bids	1/5/98	5/1/98
1.2	Award Bid/Remove Tower	6/1/98	7/31/98
2	**Construct New 2 MG Water Tower**	9/1/97	11/30/99
2.1	Select Possible Sites	9/1/97	12/31/97
2.2	Negotiate Site Purchase	1/5/98	7/1/98
2.3	Design Tower & SCADA Improvements/Bid	7/1/98	1/29/99
2.4	Award Bid/Construct Tower	2/1/99	9/30/99
2.5	Convert to Single Pressure System/Test	10/1/99	11/30/99
3	**Develop Alternate Wellfield**	1/1/98	12/30/05
3.1	Select Possible Sites	1/1/98	5/1/98
3.2	Conduct Test Drilling for Capacity and Quality	5/1/98	12/31/98
3.3	Negotiate Site Aquisition/Purchase	9/1/98	1/1/99
3.4	Develop Design/Bid 4 Wells	1/1/99	4/30/99
3.5	Design Transmission Main	1/1/99	6/1/99
3.6	Award Bid/Construct 4 Wells	6/1/99	1/3/00
3.7	Award Bid/Construct Transmission Main	7/1/99	1/3/00
3.8	Design Bid/Construct 5 Additional Wells	1/3/05	12/30/05
4	**Kilgore Island Wellfield Improvements**	1/1/98	1/1/15
4.1	Obtain Permit from D.W.R. for 30 MGD	1/1/98	10/1/98
4.2	Improve Electrical Feed to Island (D.P.P.D.)	1/1/98	12/31/98
4.3	Design/Bid 3 New Wells at 1,000 gpm	10/1/98	4/1/99
4.4	Award Bid/Construct 3 New Wells	5/3/99	10/1/99
4.5	Temporarily Convert 1983 Wells to 1,000 gpm	1/3/00	1/1/01
4.6	Design/Bid 6 New Wells	1/3/05	1/1/10
4.7	Replace 1983 Wells to 1,000 gpm	1/1/10	1/1/15
5	**Const. Alt. Kilgore Island WF Transmission Main**	1/1/98	11/1/99
5.1	Select Route	1/1/98	5/1/98
5.2	Negotiate Easements If Any	5/1/98	7/31/98
5.3	Design/Bid Transmission Main	8/3/98	3/1/99
5.4	Award Bid/Construct Transmission Main	5/3/99	11/1/99
6	**Repaint 1.5 MG Water Tower**	1/3/00	1/3/01
7	**Distribution System Improvements**	1/1/03	1/1/08
8	**Construct Additional 2 MG Water Tower**	1/1/08	1/1/15

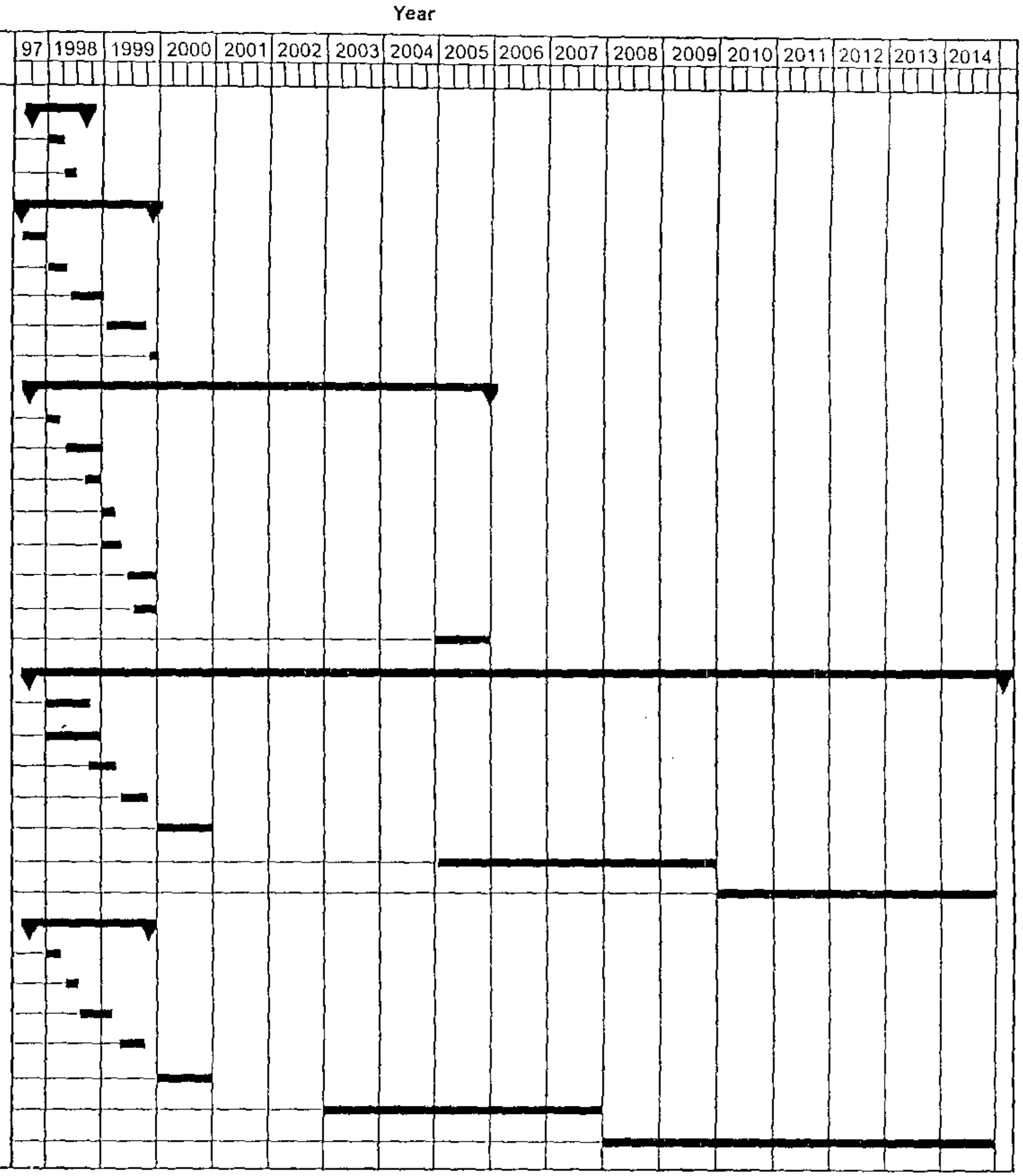

Exhibit 17
Implementation Plan