APPENDIX A - SUPPORTING ALTERNATIVES DATA TABLE

VIABLE WATER RESOURCES CRITERIA

Criteria was developed to screen each water supply alternative for capability, quality, future availability, legal issues, policy and political issues, planning horizons, environmental issues, and cost estimates and economic comparisons. The existence of major deficiencies or fatal flaws with respect to these issues for each alternative was investigated. The occurrence of a fatal flaw eliminated an alternative from further study. The most promising or viable alternatives were carried forward and evaluated in more detail. The following sections describe the criteria used in development of the water supply alternatives.

A. Water Supply Capability

Each potential water source alternative must have the capability to supply all or a part of the projected year 2050 net needs for the average day demand and the maximum day demand. Water supply capability was indicated by the following terms:

- Firm Yield
- Safe Peaking Ability
- Ability to Meet Demands
- Water Rights
- Conjunctive Use
- Peak Nonpotable Use Criteria

The interpretation of several terms varied slightly depending on whether a surface water, groundwater or reclaimed water source was involved.

1. Firm Yield

The firm yield of a surface water reservoir is sometimes considered to be the yield of the reservoir during the most severe drought of record as determined by a reservoir inflow/outflow operational study. Another approach is to consider the firm yield as one with a 2 percent chance of interruption as caused by a drought condition with a one-in-50-year recurrence cycle.

By contrast, the firm yield of a groundwater well is normally considered to be the pumping rate which will not cause incrustation or solidification damage to the aquifer formation (assuming adequate recharge from rainfall or rivers is available). Such yield is normally established by well screen entrance velocities and aquifer characteristics including water chemistry, rate of drawdown, and static groundwater level.

2. Safe Peaking Ability or Firm Capacity

"Safe" peaking ability may be determined by time of use of frequency of use or other conditions. For mechanical components, such as pumps or wells, "safe" peaking ability (or firm capacity) is figured as the available flow with the largest unit considered to be out of service. For systems with a large number of wells, such as the City's 55 wells in the Equus Beds, a larger number of mechanical units is often considered to be out of service at any given time for maintenance or emergency repair. In this case, 10 percent of the units were considered to be out of service for planning purposes when considering "safe" peaking ability or firm yield.

3 Ability to Meet Demands

The ability of a water supply to meet total water demands (either collectively with other sources or as a separate project) would likely impact costs to a significant degree. Maximum use of existing water supply-treatment infrastructure was an important consideration in the development of alternatives for cost savings. Additionally, the ability of a supply(s) to be developed in stages (which allows costs to be delayed until demands increase) was another important consideration.

4. Water Rights

The Kansas Water Office permits annual average day and maximum day withdrawal rates or water rights for water supplies. These rates are typically based on firm yield: therefore, the permitted annual average day withdrawal rate allowed by the State is typically the firm yield. Review of the city's water rights showed the maximum day withdrawal rate at about 2.2 times the average day water right for Cheney Reservoir and the Equus Beds Well Field. This maximum to average day use factor was considered in the evaluation of potential surface and groundwater supply alternatives.

5. Integrated Use

Based on discussions with the State of Kansas, an integrated use permit could be issued to the City, allowing the use of preset quantities of water from groundwater and surface water sources. Such a permit would allow the City to manage the operations of their water supplies to maximize use of excess runoff from surface water sources with accompanying groundwater recovery and storage until needed during drought conditions.

6. Peak Nonpotable use Criteria

Use of treated wastewater effluent, stormwater storage or remediated groundwater in a reclaimed water system could be used to reduce summer peak demands for potable water. Such a system(s) could be used to supply irrigation water to City parks, golf courses, or farmland and to supply nonpotable process water, cooling water, and irrigation water to large industries.

B. Water Quality

The quality of raw water from a water supply alternative and the quality of treated or finished water desired by the City were important variables because the type and cost of water treatment could vary significantly with each alternative. All finished (or drinking) water quality must meet existing and pending regulations of the Safe Drinking Water Act Amendments. Parameters such as chlorides, nitrates, atrazine, pesticides, etc. were important since these constituents require special treatment processes for removal which impact costs. Use of high-chloride groundwater, for example, may require raw water blending or reverse osmosis treatment and product blending to obtain acceptable chloride levels of under 250 mg/L.

Water supply alternatives involving aquifer recharge may need treatment of recharge water to meet requirements by the Kansas Department of Health and Environment (KDHE). KDHE typically looks at each recharge application on a case-by-case basis with the general guideline that the recharge water should not degrade water quality in the aquifer. At this time, KDHE has no minimum water quality standards for aquifer recharge and subsurface storage.

C. Legal Issues

The amended Kansas Water Transfer Act applies to any water supply alternative that transfers more than 2,000 acre-feet of water a distance of more than 35 miles. The purpose of this law is "to determine whether the benefits to the State for approving the transfer outweighs the benefits to the State for not approving the transfer." As such, consideration of this law was important in the evaluation of almost all water supply alternatives for the City.

Transfer applications are evaluated by a "transfer panel", consisting of the Chief Engineer and two other state agency directors. As the act is currently written, many of the alternatives evaluated required obtaining the necessary approval before water could be transferred. An effective water conservation program is also required in order to obtain approval of a water transfer.

D. Policy and Political Issues

Policy issues considered included the City's purchase of water rights from groundwater irrigators and use of City's right of condemnation. Political issues associated with each water supply alternative were considered since any significant opposition could cause long-term delays, substantial cost increases, litigation and the eventual canceling of a project. For example, a concern with the proposed Milford Project was the water needs of Northeast Kansas pitted against those of South-Central Kansas.

E. Future Availability

Future availability of a water supply may be related to the ability of the City to execute the plan given a number of regulatory, social, economic and political constraints. For example, in today's regulatory climate with wetlands issues and emphasis on environmental concerns, entering into a planning phase with the goal of constructing a new reservoir would likely be a very difficult, time-consuming process with no assurance of success. Other factors also considered included continuing development and the need for water by other communities, which could eliminate remaining available water supplies over the next 10 to 50 year period.

F. Planning Horizon

Each water supply alternative, individually or as part of a larger water supply plan, was scheduled for implementation in phases or stages to meet the City's net water needs from year 2000 through year 2050.

G. Environmental Issues

Environmental issues associated with each alternative were evaluated to determine if a possible environmental "deficiency" or "fatal flaw" existed. Typical fatal flaws dealt with the presence of federal endangered species or wetlands or other significant environmental impacts.

Various environmental areas of concern involved the following:

- Relocations (Dwelling, Churches, and
- Biological Resources

Cemeteries
- Land or Right-of-Way Required for Project
- Timber Removal
- Inundation of Rivers and Streams
- Wetlands
- Cultural Resources
  - Federal Endangered Species
  - Federal Threatened Species
  - State Endangered Species
  - State Rare Species
- State Forests and Natural Area

H. Cost Estimates and Economic Comparisons

Cost estimates for water supply alternatives developed in previous studies by others were reviewed and updated. Cost estimates for new water supply alternatives developed as a result of this study required the conceptual design of facilities for the purpose of determining preliminary sizes and quantities of materials and components. Unit cost data and component cost information from historical projects are used in the estimates. Determination of OMR&E costs required preliminary consideration of how each plan would function in relation to existing water system facilities. All costs were developed for an Engineering News Record (ENR) construction cost index of 5037 for the Kansas City regional area for March 1993.

Project costs estimates and costs per unit of available flow estimates were required for the purpose of comparing each water supply alternative to determine the most economically viable alternative(s). Estimates of cost per unit of available flow were based on the total project cost divided by the total available flow over a 55-year period from 1996 through 2050. This time frame was used for most alternatives and allowed the alternatives to be evaluated on an equal basis. Some alternatives, like Milford, could not be completed in time to be in service in 1996 and were based on 50 years of operation. Potential water supplies with unit costs greater than the Milford Reservoir Alternative were generally considered nonviable from a cost basis.

"Other Costs" included engineering, administration, inspection, geotechnical, survey, environmental and legal work associated with the project. These costs were estimated at 15 percent of the construction cost including the contingency and varied with the size and scope of the project. The contingency of 20 percent on construction costs accounted for unknown and unaccounted-for construction items not typically detailed at the current stage of project development.

SELECTION OF VIABLE ALTERNATIVES

Potential water sources, consisting of conventional and nonconventional alternatives, throughout the regional area in and around Wichita were evaluated. Conventional alternatives included existing and proposed reservoirs, groundwater and surface water flow. Nonconventional alternatives included use of reservoir overflows, excess stream flow, treated wastewater reuse, groundwater bank storage, rain harvesting and water conservation. The 27 water supply alternatives were evaluated according the above criteria, 11 were considered viable. Appendix A contains a table summarizing the water supply alternatives versus the criteria. The most feasible alternatives from the 11 consider viable were used to develop two basic water supply plans capable of meeting the projected water needs of the City's water service area through the year 2050. These two plans are evaluated in this EIS.

Appendix A
Initial Water Supply Alternative Ranking Summary

Alternative	Construction Costs ($million)	Available Flow	Unit Cost ($/MG)	Issues				Advantages	Disadvantages	Rank
				Policy/ Political	Legal	Environmental	Water Quality			
Kanapolis	69	10 MGD firm yield 200,800 MG[1]	344	Water Transfer Act	Must obtain additional water rights		Periodic high chlorides; Questionable	Firm supply	Water quality concerns Difficult to obtain all of the water rights	NS[2]
Milford Reservoir	155	60 MGD firm yield 1,095,000 MG[1]	141	Water Transfer Act Potential conflict with northeast Kansas	Must obtain additional water rights		Moderately hard; Adequate	Single sources; Firm supply ; Regional supply	Political problems Availability under Investigation by State	9
Corbin Reservoir	470	35 MGD firm yield 702,600 MG[1] Max yield of 53 MGD	669		Must obtain additional water rights	Significant impact associated with new reservoir construction	Expected to be adequate	Firm supply; Recreation	Significant environmental Impact	NS
Douglas Reservoir	202	14.2 MGD firm yield 285,100 MG[1]	707		Must obtain additional water rights	Significant impact associated with new reservoir construction	Expected to be poor	Firm supply; Recreation; Flood control	Significant environmental impact Poor water quality	NS
Murdock reservoir	231	35 MGD firm yield 702,600 MG[1] Max yield of 65 MGD	329		Must obtain additional water rights	Significant impact associated with new reservoir construction	High chlorides; Questionable	Firm supply; Recreation	Significant environmental impact Questionable water quality	NS
Equus Beds: Purchase Water Rights	$400/Ac-Ft	As Available	NA		Must obtain additional water rights		Generally good	Low cost; Close to well field; Good water quality	Availability concerns	8
Equus Beds: Burrton SWQUA & IGUCA	26	9.8 MGD firm yield 196,700 MG[1]. 100% use	130		Must obtain additional water rights	Remediate area over time	Very high chlorides	Long-term supply for City; Potential aquifer remediation	Availability concerns Poor water quality	NS
Haysville Groundwater	22	2.85 MGD firm yield 57,200 MG[1]. 100% use	386		Must obtain additional water rights	Remediate area over time	Very high chlorides	Long-term supply for City Potential aquifer remediation	Availability concerns Poor water quality	NS
Reserve Well Field	1 1	10,8 MGD firm yield 216,800 MG[1] 100 % use 10.8 MGD firm yield 27,300 MG[1] Peak use	4.7 37		Must obtain additional water rights		Poor; High Chlorides & hardness; Affects of long-term pumping unknown	Low cost; Firm supply; Supplement Peak demands	Poor water quality High chlorides Additional treatment cost	6
Gilbert-Mosley Remediated Groundwater	1.5	Continuous supply of 3 MGD	25			Conserves water, not conveyed WWTP	Adequate	Low cost; Conserves resources; Firm supply		4
Arkansas River Supply to WTP	21	0 Firm Yield; 155,800 MG[1] as available (avg. 8 MGD)	132	Integrated water use permit required	Must obtain additional water rights		High flows required for acceptable WQ	Close to WTP; Low cost	Poor water quality Low available flows	NS
Little Arkansas River Supply to WTP	21	0 Firm Yield; 880,000 MG[1] as available (avg. 44 MGD)	23	Integrated water use permit required	Must obtain additional water rights		Good	Close to WTP; Low construction cost; High available flows	Poor water quality No firm yield	2
Cheney Reservoir: Operations Modifications	0	Withdrawal up to about 60 MGD	0	Integrated water use permit required	Must obtain additional water rights	Potential impact on reservoir due to water level variations	Adequate	Increased water availability	Recreation impacts Public relations impacts Increased probability shortage	5
Cheney Reservoir: Purchase Flood Storage	0	Estimated 3 MGD yield for 1 ft, 2 MGD for 2 ft, & 1 MGD for 3 ft		Integrated water use permit required	Must obtain additional water rights	Potential impact on reservoir due to water level variations	Adequate	Increased firm yield	Recreation impacts Public relations impacts Extensive relocations	*

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Initial Water Supply Alternative Ranking Summary

Alternative	Construction Costs ($million)	Available Flow	Unit Cost ($/MG)	Issues				Advantages	Disadvantages	Rank
				Policy/ Political	Legal	Environmental	Water Quality			
Membrane Filtration Plant	191 34	60 MGD Capacity 10 MGD Capacity	158 168			Brine disposal	Poor; Potable WQ after treatment	Source of the future	Very high operating cost Brine disposal 2% yield of 32 MGD	NS
Cheney Overflow: Pipeline to WTP	53 60	554,400 MG[1] as available (avg. 28 MGD) 695,000 MG[1] as available (avg. 35 MGD)	96 87	Integrated water use permit required	Must obtain additional water rights		Adequate	Uses excess flow; Conserves resources; Allows Equus Beds to recharge	No firm yield	7
Cheney Overflow: Side Storage Reservoir	NA	NA	NA	Integrated water use permit required	Must obtain additional water rights	Significant impact associated with new reservoir construction	Expected to be poor	Uses excess flow; Conserves resources; Recharges Equus Beds	No sites Aesthetic problems Operational problems Multiple pumping req'd	NS
Cheney Overflow: Subsurface Storage	65 / 165**	695,000 MG[1] as available (avg. 34 MGD)	94 / 237**	Account for stored water Integrated water use permit required	Must obtain additional water rights	Potential for Equus Beds groundwater quality degradation	High Chlorides, about 200 mg/l	Uses excess flow; Conserves resources; Recharges Equus Beds	High chlorides No firm yield State may not approve	10
Little Arkansas River: Subsurface Storage	26 / 126**	0 Firm Yield; 574,200 MG[1] as available (avg. 29 MGD)	46 / 219**	Account for stored water Integrated water use permit required	Must obtain additional water rights		Adequate	Conserves resources; Low cost	No firm yield	3A
Treated Wastewater Reuse: Local Irrigation	15	Avg. firm yield of 1.1 MGD for 55 year study period 11,000 MG[1]	1336			Potential impacts	Adequate	Reduces summer peak; Generates revenue; Conserves resources	No public access during irrigation cycle	11
Treated Wastewater Reuse: Subsurface Storage	130 / 230**	Avg. firm yield of 68 MGD for 55 year study period	96 / 169**	Account for stored water Integrated water use permit required	Must obtain additional water rights	Potential to degrade aquifer water quality	High chlorides, 200 mg/l	Firm supply; Conserves resources; Recharges Equus Beds	High construction cost Water quality concerns	NS
Treated Wastewater Reuse: Sell to Irrigators	129	Avg. firm yield of 68 MGD for 55 year study period	95		Must obtain additional water rights	Water is borderline quality for irrigation	Marginal, farmers should initiate a management program for soil	Generates revenue; Obtains water rights; Conserves resources	High construction cost Water quality concerns	NS
Little Arkansas River: Bank Storage	6.2 to 175 11.5 to 164	0 Firm Yield; variable with units installed, range from 7 to 39 MGD	45 to 221 41 to 207	Account for stored water Integrated water use permit required	Must obtain additional water rights	Effects must be evaluated	Good	Phased construction; Use injection wells; Water available for an extended time period	No firm yield Potential impacts on other users	3B*
Rain Harvesting	.6 Unit	Firm Yield of .007 MGD/unit	4117	Account for stored water Integrated water use permit required	Must obtain additional water rights		Good	Good water quality	Low available volume Very high unit cost	NS
Excess Potable Water: Subsurface Storage				Account for stored water Integrated water use permit required	Must obtain additional water rights		Must be monitored; Treat to potable standards	Conserves resources	Insufficient land available for storage Water quality concerns	NS
Low Range Water Conservation	23	279,500 MG[1] with an avg. savings of 15 MGD	77					Other cost savings to be realized; Reduces max day; Conserves resources		1
No Action	0	Reduces year 2050 max day demand 23 MGD	0					Reduces demand, max day net need is 14	Reduces service area Reduces tax base	NS

Notes:

[1]Over a 55 year period form 1996 to 2050

[2]"NS" = not selected

* Requires highly detailed study to confirm viability.

** Includes Equus Beds Well Improvements.