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MUNICIPAL WATER RESOURCES ANALYSIS FOR AREA POTENTIALLY IMPACTED BY MX MISSILE COMPLEX IN UTAH

by

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SCOPE OF REPORT

This report analyzes the impact of the proposed MX Missile complex upon existing municipal water supply and waste treatment systems serving selected communities either near the perimeter or within the Utah portion of the proposed MX complex boundary. As can be seen from the location map in Figure 1, possible sites for elements within the total MX missile complex have been identified in 14 Utah desert valleys in the five counties, from north to south, of Tooele, Juab, Millard, Beaver, and Iron.

The 60,000 people, who live in these counties according to the 1975 census, are largely located in their eastern ends of the base of a series of mountain ranges with numerous peaks over 10,000 feet. Sites closer to these mountains have a more dependable and higher quality water supply from the snowpack runoff. Surface runoff evaporates or infiltrates underground and waters generally become more saline as one moves further west into the desert. The desert ranges, separating the 14 valleys, are lower, generate much less runoff, and streams flow only for short periods, during spring snowmelt or summer thunderstorms, to recharge aquifers along the basin margins.

Interstate 15, the main highway from Salt Lake to Las Vegas, passes through the towns of Nephi, Fillmore, Beaver, Parowan, and Cedar City and the best farming country in the region along the base of the mountain ranges at the eastern edge of these counties. About 20 miles further west, the Union Pacific Railroad corridor passes through the towns of Delta and Milford and several small villages of population less than 50 as it roughly demarcates the farming country to the east from the desert

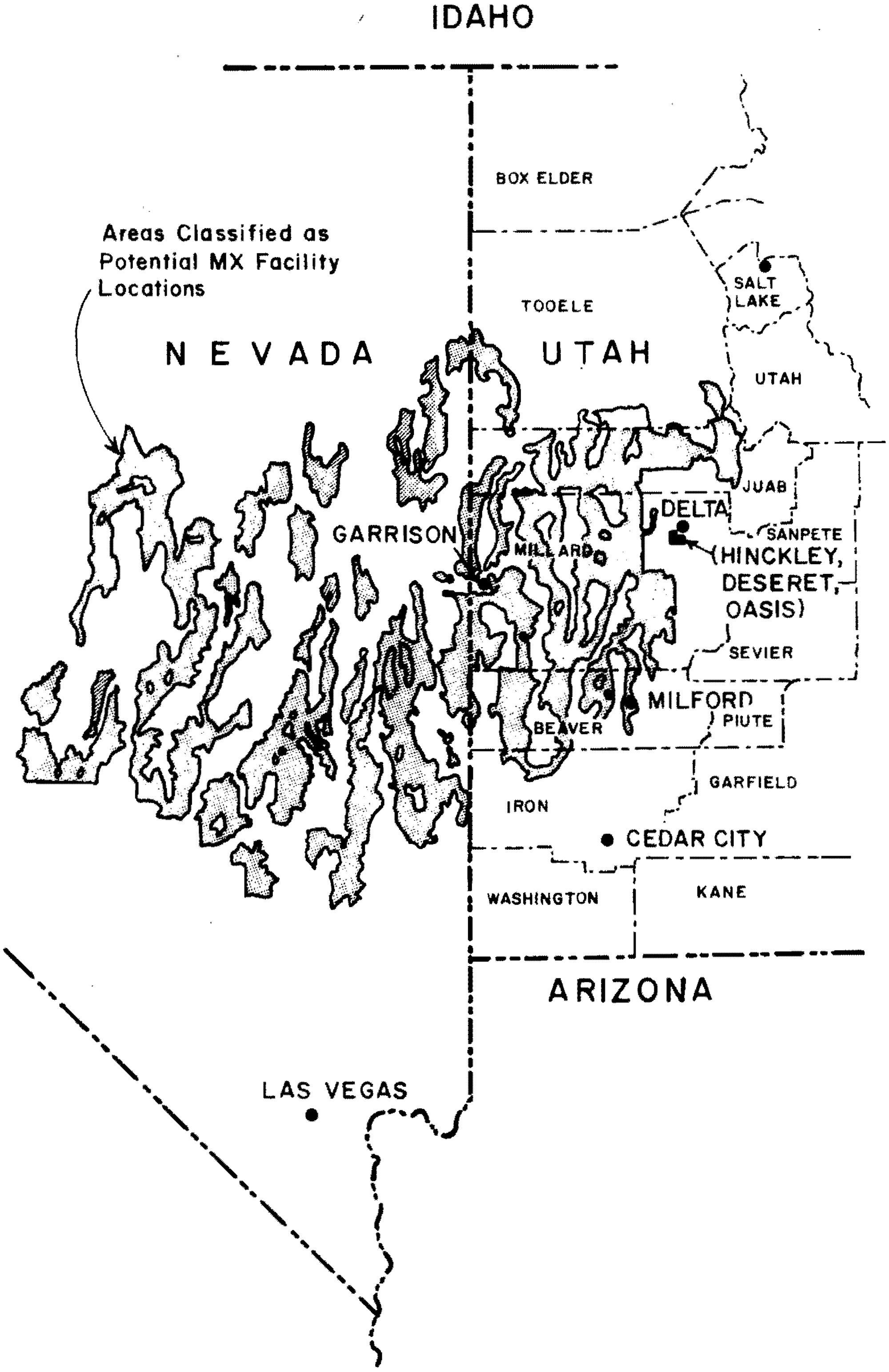

Figure 1. MX impact area location map.

valleys being considered as MX missile sites further west. The 100-mile wide strip between the Union Pacific Corridor and the Nevada border is extremely sparsely inhabited with the largest single community being the 60 people who live at Garrison.

Generally, nature provides more water on the basin margins along the eastern sides of these five counties. However, because the water is more readily available and easier to develop there, almost all available supplies are fully appropriated and new users can only obtain water by purchasing prior rights. Further west, surface water (and therefore early development) has been very limited, and significant amounts of groundwater remain unappropriated. Much would have to be pumped from deeper aquifers.

The specific communities assigned for analysis of their water supply and wastewater treatment systems in this study are Delta, Milford and Cedar City plus an overview of impact upon the water supply situation in the smaller communities of Hinckley, Deseret, Oasis (all a few miles southwest of Delta) and Garrison, near the Utah-Nevada border. The locations of these cities and villages in relation to the potential MX storage sites are shown in Figure 1.

The report begins by presenting the pertinent hydrologic information, particularly groundwater hydrology, for areas immediately adjacent to the communities of interest. The hydrology of the other valleys where the MX sites are contemplated is not within the scope of this report.

The second major section of the report is a description of the existing municipal water systems for these seven communities, their current water requirements, their capacity without any expansion, and, finally, an assessment of the expansion in water rights and various components of each system which would be required to serve an assumed MX related growth scenario in each region.

The final section is a similar analysis of existing wastewater collection and treatment facilities and of how they would be affected by the growth scenarios. In addition to possible MX related growth, the Delta area is also facing probable construction of a very large coal-fired power generating complex known as the Intermountain Power Project (IPP). The water and wastewater demand projections are based upon assumed normal growth "without MX" (including the proposed Intermountain Power Project (IPP) impact in the Delta area) plus MX related growth. The MX-related population growth projected for Utah amounts to a population increase of 30,000 (employees, dependents and indirect) by 1987 at the peak of MX construction. The population increase was assumed to be distributed by community as follows:

Area	MX Peak Population
Delta	12,500 (10,250 in Delta and 2250 in Hinckley/Deseret/Oasis)
Milford	12,500
Cedar City	5,000

About slightly over half of this MX-induced population would be expected to remain after 1995 when construction is completed.

Since MX base siting information is not yet available. These estimates are simply one possible scenario. For convenience in using the results of this study with various projections, the impact of population growth upon water resources in each area is tabulated in per person or per connection as well as total volume dimensions so that the water impacts associated with various projections can easily be calculated.

HYDROLOGIC SYSTEMS

Since the available surface water supplies in all locations within the areas of interest are completely allocated for other beneficial uses and since groundwater is much more desirable for municipal use due to minimal treatment required, the hydrologic analysis will be limited to groundwater resources in the vicinity of the seven communities of interest.

I. Milford City

1. Occurrence and Movement of Groundwater.

The unconsolidated materials underlying the Milford area contain the principal groundwater reservoir. This groundwater reservoir consists of three zones of high permeability separated by zones of low permeability. the thickness of this reservoir varies throughout the valley, reaches a maximum of about 840 feet about 21 miles south of Milford. Groundwater moves from deeper to shallower zones within the groundwater reservoir throughout most of the valley because the hydrostatic pressure in the deeper zones causes upward leakage through the confining beds into shallower zones. The general direction of water movement in the principal groundwater reservoir as indicated by water level contours is to the north.

2. Groundwater Budget.

Based on the groundwater budget estimated by Mower and Cordova (1974) an appraisal of the recharge to and discharge from the principal Milford Valley groundwater reservoir for the year 1970-71 is shown in Table 1. This year was close to average in terms of moisture availability. The estimates indicate that the consumptive use of phreatophytes (in the

Table 1. Milford Valley groundwater budget, 1970-71 (Mower and Cordova, 1974).

Hydrologic Parameter	Source	Quantity
1. Recharge	Subsurface inflow:	1,700 acre feet
	Tributary Valleys	
	Big Wash	2,200 acre feet
	Bed Rock	16,000 acre feet
	Seepage: Streams	5,000 acre feet
	Canals	8,500 acre feet
	Deep percolation from farm land	22,700 acre feet
	Infiltration from precipitation	2,100 acre feet
	Total	58,200 acre feet
2. Discharge	Irrigation	56,000 acre feet
	Public supply and industrial	800 acre feet
	Domestic and stock	100 acre feet
	Evapotranspiration from groundwater	24,000 acre feet
	Thermo hot springs	100 acre feet
	Subsurface and flow to black rock desert	Negligible
	Total	81,000 acre feet
3. Storage	Entire groundwater reservoir	40 Million ac ft
4. Releases from storage	Per 1 foot of water level decline (March 1972 altitude)	84,000 acre feet
	Per 1 foot of water level decline (100 feet lower than March 1972 altitude)	52,000 acre feet

nonirrigated low lying lands) accounts for 30 percent of the annual discharge from the groundwater basin. Irrigation is the major use of groundwater--70 percent of total discharge and 98 percent of beneficial use. Municipal and industrial users divert less than 2 percent of annual beneficial use.

3. Trend in Water Levels and Groundwater Storage.

The time series of plotted depths to groundwater through the spring of 1979 (Figure 2) indicate that the increased pumping of groundwater, especially since about 1950, combined with low normal precipitation during the 1960's, has dropped the water level as much as 30 feet (1 foot per year average) and reduced aquifer storage by about 410,000 acre-feet. This decline in water levels has caused compaction and land subsidence in the areas of heavy pumping south of Milford. As the water table drops, each additional foot of decline occurs with less water mined. As a result of this mining of groundwater the State Water Rights Engineer has closed the basin to further water appropriation.

4. Interference Among Wells.

Even though new appropriations are not granted, a municipality can purchase water previously pumped by an irrigator and drill a new well at a more convenient location. Before permitting this, the State Engineer must be convinced that the shift will not cause undue interference with older wells near the new municipal well site. Mower and Cordova (1974) reported the results of a hypothetical study indicating that significant interference among wells could occur in the Milford Valley. As an example, pumping a 1000-gpm well for 180 days could cause drawdown at a

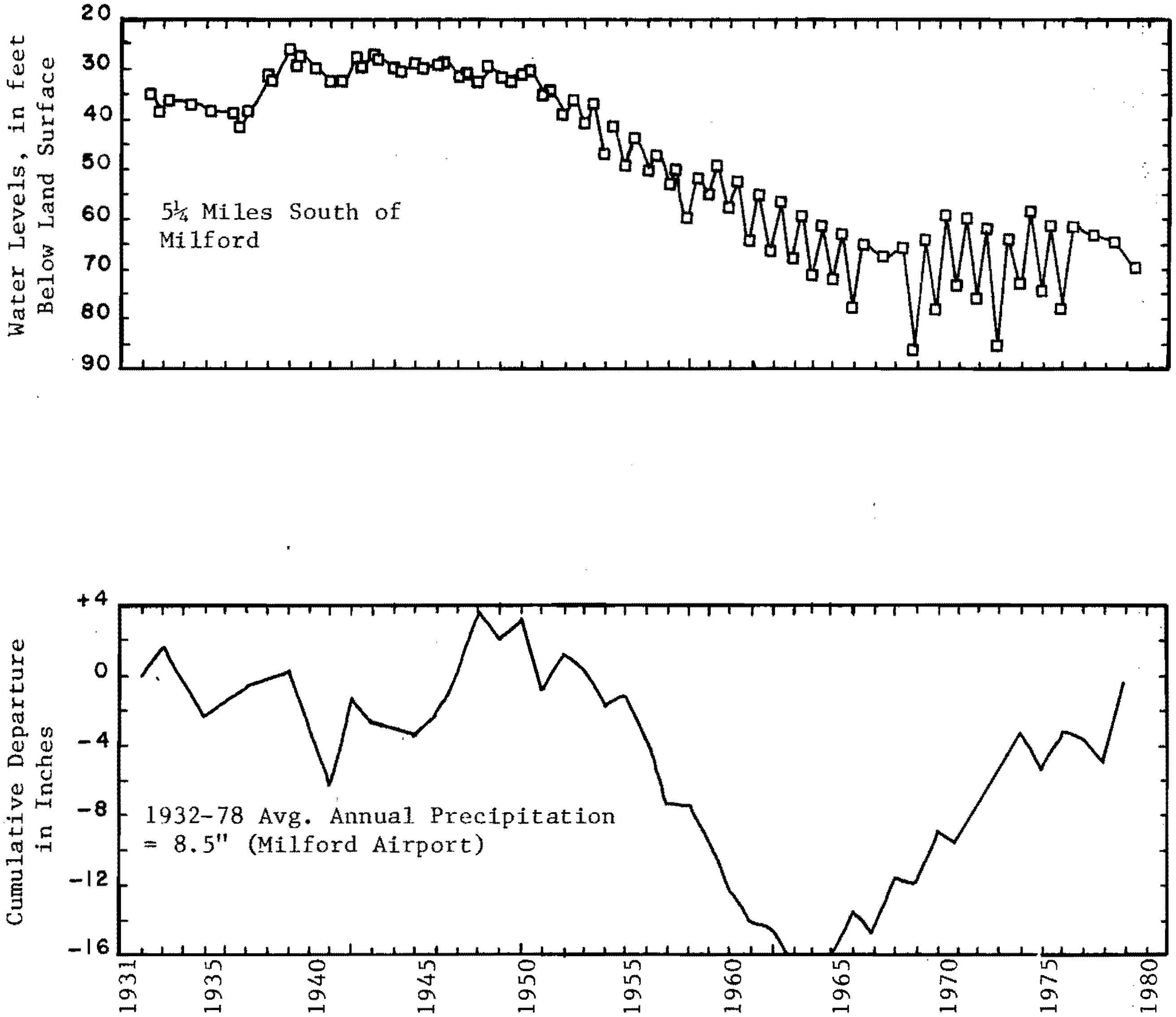

Figure 2. Relation of water levels in Milford area to cumulative departure from average annual precipitation.

well 1 mile away of 2.5 to 7.5 feet for a corresponding range of transmissivity value of 10,000 - 40,000 ft^2/day (storage coefficient assumed at 0.001).

5. Effect of Pumping Layered Aquifers.

The current usual upward hydraulic gradient from the deeper to shallower water bearing zones in this valley may be reversed locally by pumping, causing the hydraulic head in deeper zones to decline below the head in shallower zones. During such periods, poor quality water (from canal seepage and deep percolation from irrigated fields) moving through the shallower zones may mix into groundwater in the deep zones. Progressive water quality deterioration results.

6. Water Quality.

The culinary wells in Milford City have low dissolved solids content (about 230 mg/l). However, because of salinity moving in from shallow aquifers associated with groundwater mining in recent years, the chemical quality has been deteriorating in the Milford Valley. Data reported by Mower and Cordova (1974) indicate that the median dissolved solids (TDS) content of the well water supplies in the entire valley is 570 mg/l. The wells pumping from a shallow aquifer in the vicinity of Milford had much higher TDS content, for example -(1) 3360 mg/l in a well located north of Milford; and (2) some irrigation wells south of town contained 2310 to 2950 mg/l. Such water is from an aquifer much more shallow than that which the City wells use; however, mixing between the aquifers if groundwater mining is increased is a possibility.

7. Prospects for Further Groundwater Development.

Because of the dropping water table caused by pumping at a rate faster than the recharge and associated salinity increases, the Utah Division of Water Rights has closed the groundwater basin to new water development. If Milford's municipal supply is to be increased by purchasing existing irrigation rights, careful attention should be given to well location and capacity so as to minimize both interference among wells, and water quality deterioration due to excessive local drawdown. New wells need to be located where they will not reduce the head in the deeper aquifers to the point of reversing the hydraulic gradient and causing entry of water from the more saline shallow aquifers.

II. Delta City

1. Occurrence and Movement of Groundwater.

Interbedded basin fill deposits (coarse unconsolidated sediment) form the groundwater reservoir beneath Delta City. The aquifer system exceeds 1000 feet in thickness and is composed of the lower artesian, the upper artesian, and the shallow water table zones. The beds of the coarser material in each artesian aquifers are connected laterally, but locally they are separated vertically by fine-grained beds, resulting in impeding the vertical movement of water. The general direction of water movement in the upper artesian and unconfined aquifers (as indicated by water level contours) is toward Sevier Lake (Mower and Feltis, 1968) to the southwest.

2. Groundwater Budget.

No groundwater budget analysis such as that reported for Milford is available for Delta. The best that could be developed is the semi-quantitative assessment made for this study and reported in Table 2. The indication is that 1) seepage from streams and canals are probably the

Table 2. Delta area groundwater budget (after Mower and Feltis, 1968).

Hydrologic Parameter	Source	Quantity Acre-Feet
1. Recharge	Infiltration from precipitation	5,000 - 12,000
	Seepage from streams and canals	Major recharge
	Irrigated fields	25% of water diverted
	Inflow from unconsolidated rocks	Not estimated
	Underflow from other basins from	
	Pavant Valley	14,000
	Beaver River	1,000
2. Discharge	Subsurface outflow	<5,000
	Flowing wells	<1,500
	Pumped wells	29,000
	ET from phreatophytes	135,000 - 175,000
	Evaporation from Severe lake playa	2,000
3. Storage	(2000 sq mi x 775 feet thick x .40 water content)	1 billion
4. Water release from storage	For 20 ft reduction in piezometric head	120,000

major sources of recharge and 2) although the total storage in the groundwater aquifer is about 1 billion acre feet, the estimated water release from the storage would be only 120,000 acre feet for a 20 foot reduction in the piezometric head.

3. Trend in Water Levels.

While water level data are not available for Delta City, the water levels have declined over the years since the wells were originally constructed, as evidenced by the need to increase the stem lengths for the pumps to be able to pump water at all times. The highest annual water level is usually in March, after which levels drop with heavy irrigation withdrawals during the irrigation season. The long term trend in water levels in two wells near Delta City (Figure 3) indicate a long-term trend of declining artesian head. However, during the period March 1978 - March 1979, the observed rise in the upper artesian aquifer was 2.6 feet in an observation well located about 2 miles southeast of Delta (Don Price, 1979). The increase was probably due to the above normal precipitation in the area resulting in reduced groundwater withdrawals for irrigation.

4. Interference Among Wells.

Although no study was done at Delta City, the studies of Mower and Feltis (1968) in the Lynndyl area (about 8 miles to the northeast) indicate that significant interference could also occur in the vicinity of Delta City. For a 1000-gpm pumping for 180 days, the water level decline could be about 7 feet in a well located at a distance of 2 miles, assuming a transmissivity of 50,000 gpd/foot and a storage coefficient of 0.001. Since the groundwater is extensively used in this valley, it will be necessary to consider the interference aspects in locating new wells for additional water supplies.

5. Effect of Pumping the Upper and Lower Artesian Aquifers.

The lower artesian aquifer is tapped by the municipal wells in Delta, while elsewhere in the valley the upper artesian aquifer is tapped by most of the domestic and stock wells. Data are not available to estimate the effects of simultaneous pumping of both the upper and lower aquifers in the vicinity of Delta. If appreciable leakage exists through the aquitard separating the upper and lower artesian aquifers, water quality deterioration could be expected to result from the simultaneous pumping from both the aquifers.

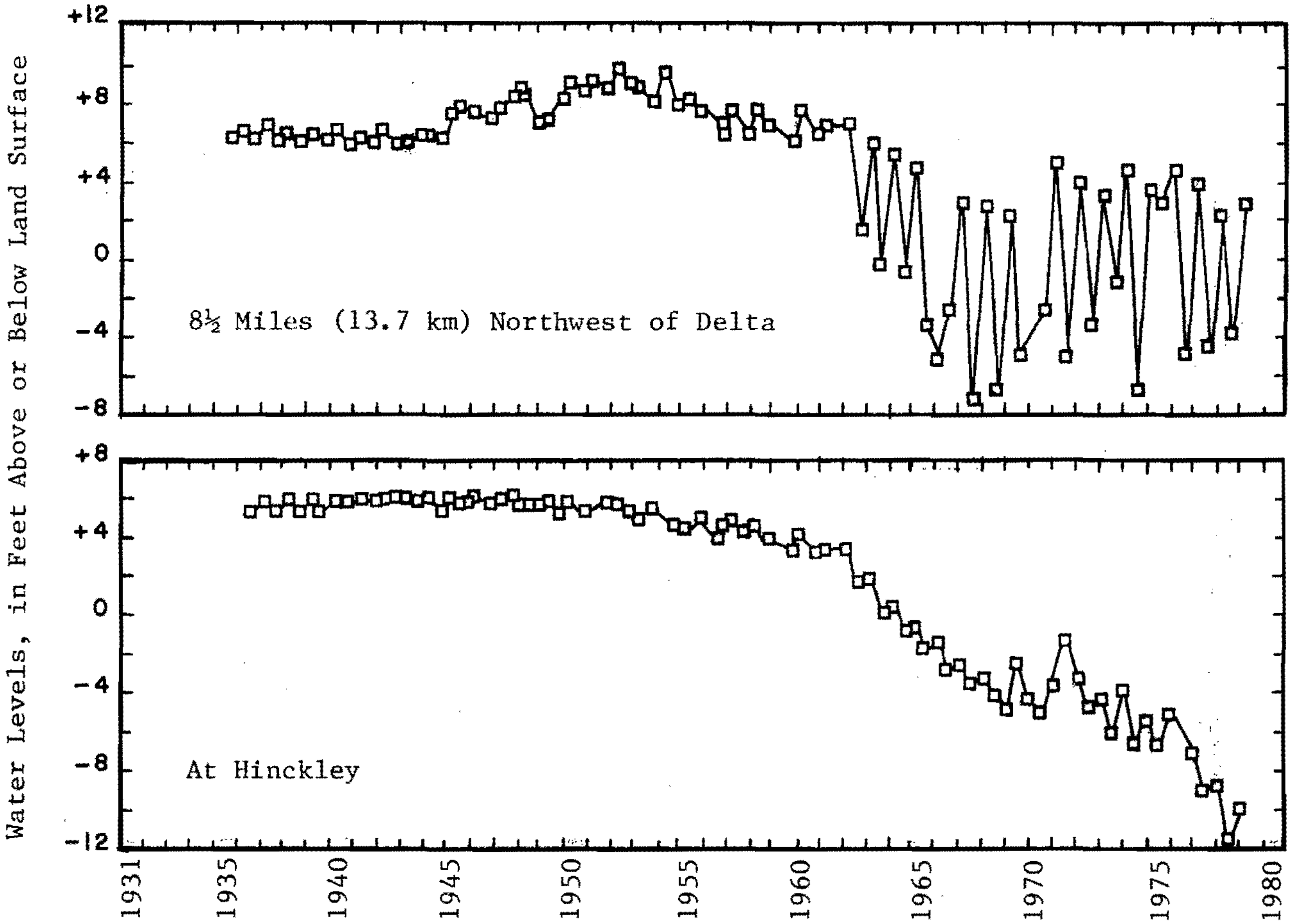

Figure 3. Long term trend in water levels in selected wells near Delta City and Hinckley.

6. Water Quality.

Presently, the Delta City culinary supply is of excellent quality as the City is located where it can take advantage of the fresh water supply recharged from the Sevier River into the upper and lower artesian aquifers. The TDS concentration in the vicinity of the town is 250 - 500 mg/l. Concentrations of over 2000 mg/l may be found to the southwest and also upstream from Delta due to highly saline water from irrigation recharge. The fresh water is percolating slowly toward the southwest, and it is being followed by saline water. Under the present hydraulic gradients, and present level of development in this area, water containing 1,000 ppm of dissolved solids are forecast to reach the Delta area in 100 - 150 years (Mower and Feltis, 1968).

Although Delta City does not treat its present culinary water supply, careful observation of the arsenic and fluoride levels in the culinary supply is recommended as a precautionary measure. Groundwater to the south contains very high levels of arsenic (see Hinckley water system discussion).

7. Prospects of Further Groundwater Development.

The Utah State Division of Water Rights will not allow additional groundwater (or surface water) development in this basin. As in the case of Milford, additional municipal supply will have to be developed via change in use of some existing irrigation right.

Of the 29,000 acre feet currently being pumped from the aquifers (Table 2) only 555 acre feet (2 percent) is being used for municipal purposes. A major increase in this amount (and corresponding decrease in irrigation) should be possible with little hydrologic impact _if_ the new wells are properly sized and located, considering local interference and water quality. In this regard, it is important to note that although Delta's municipal wells produce excellent quality water, only 4 miles to the south and west groundwater is unsuitable because of arsenic levels and only a few miles north, groundwater contains unacceptable levels of salinity, therefore a major new municipal well field represents a difficult balance between interference and quality. It may be necessary to accept significant interference in order to obtain adequate culinary quality.

III. Cedar City

1. Occurrence and Movement of Groundwater.

Productive groundwater aquifers in the vicinity of Cedar City are limited to the springs located in the upland or bed rock areas in the mountain slopes and to the unconsolidated valley fills. Three particular areas where groundwater is relatively available are the Coal Creek alluvial fan, an area west of Quichapa Lake, and the Quichapa Lake playa area. Groundwater in the unconsolidated valley fill occurs under leaky artesian conditions. But along the mountain front at, and north of, Cedar City, it exists under unconfined conditions. The general direction of movement of groundwater is toward the valley floors. Locally the direction of movement could be altered or reversed by pumping.

2. Groundwater Budget.

Most of the precipitation is consumed by evaporation and transpiration by vegetation in the basin, and only a small percentage percolates to the groundwater reservoirs. Based on the hydrologic estimates of Bjorklund et al. (1978), an appraisal of the recharge to and discharge from the principal groundwater reservoirs for 1974 is shown in Table 3. The annual water balance suggests a net annual decrease in groundwater storage of approximately 4400 acre feet and a general decline in the water levels.

3. Trend in Water Levels.

The time trend in depth to groundwater to the spring of 1979 (Figure 4) shows a general decline in water level. Seasonal fluctuations in the

Table 3. Cedar City vicinity groundwater budget 1974 (Bjorklund et al., 1978).

Hydrologic Parameter	Source	Quantity
1. Recharge	- Directly from precipitation	40,000 acre feet
	- Springs from bed rock and mountain slopes	Unknown
	- Seepage from stream diviersions (6,000 - 12,000 acre feet)	Unknown
	- Subsurface inflow	Unknown
2. Discharge	Seeps	< 500
	Evapotranspiration	
	Surrounding Quichapa Lake	1,600
	Quichapa Lake	500
	Wells	42,300
	Total (excluding e.t. from phreatophytes)	44,900
3. Storage	Unconsolidated valley fills	20 Million
	Consolidated rocks in the mountains	Not estimated
4. Release from storage		A small percentage is economically feasible

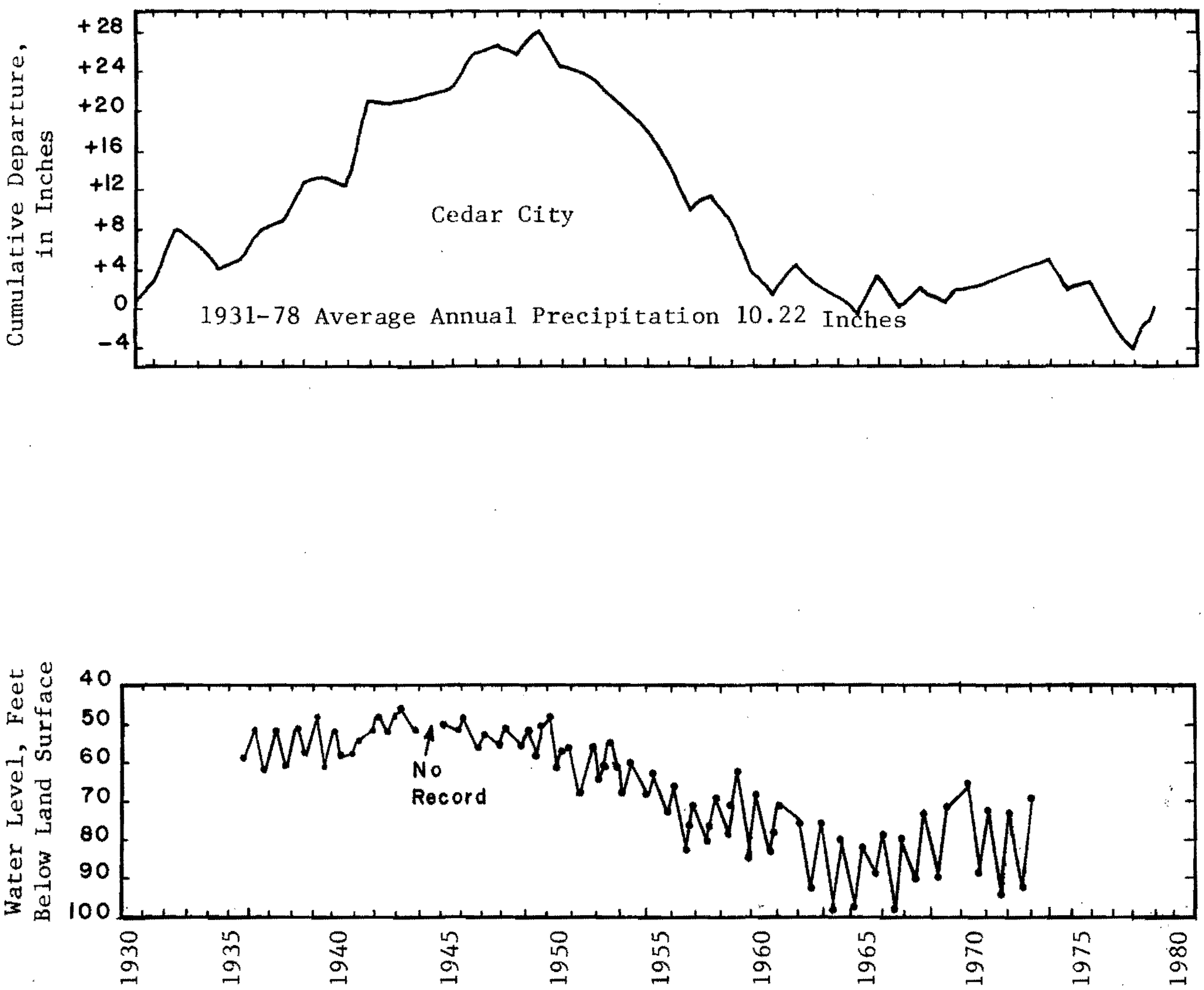

Figure 4. Relation of water levels in selected wells in the Cedar City area to cumulative departure from average annual precipitation.

water level also occur with spring recharge and summer pumping. During the wet period March 1978 - March 1979, however, significant rises in water levels occurred in the vicinity of Cedar City.

4. Interference Among Wells.

In artesian areas, such as most of the Cedar City Valley, drawdown by interference and recovery when pumping stops are both relatively rapid and affect large areas because the interference is caused mostly by a reduction in hydrostatic pressure in the confined aquifer. Measurements in the general area presently supplying water to Cedar City were reported by Bjorklund et al. (1978) as shown in Table 4. Because of the large number of wells already pumping in the Cedar City Valley and these artesian conditions, it is especially important to consider interference aspects in locating new wells for additional water supplies near City City.

Table 4. Interference drawdown in wells near Quichapa Lake, Cedar City Valley.

Pumping Quantity gpm	Distance of Observation Well (feet)	Interference Drawdown (ft)	
		Drawdown (feet)	Time
1345	652	0	3 minutes
		2.76	30 hours
845	1000	0	2 minutes
		15.16	46.1 hours
	2650	0	3 hours
		5.5	86 hours

5. Water Quality.

Presently, water of relatively low dissolved solids (less than 400 ppm) occurs in the Cedar City Valley. The water is generally classified as a calcium or magnesium sulphate type due to the gypsum bearing rocks which are exposed in the basin. Since the groundwater basin is essentially a closed basin and since the groundwater is extensively used in the valley for irrigation, long term deterioration in water quality is expected over the years. The data, however, are insufficient for quantitative projection.

6. Prospects of Groundwater Development.

The groundwater resource in the unconsolidated alluvial aquifers in the Cedar City Valley should be regarded as fully developed and closed to large new wells (Bjorklund et al., 1978). The State Division of Water Rights agrees with this assessment and has closed the basin to further water development. In seeking sources for additional culinary supplies, consideration may be given to 1) purchasing irrigation water rights, and 2) developing new groundwater resources in deeper bed rock aquifers (Navajo sand stone) in the mountains east of the City. The City recently drilled a test well into the Navajo sand stone but was unsuccessful in locating a significant quantity of water.

IV. Hinckley, Deseret, and Oasis

The three communities, Hinckley, Deseret, and Oasis, located about 8 miles southwest of Delta, are underlain by the same aquifer as Delta but far enough downstream for the water to be much more saline. The groundwater beneath these communities is comprised of three zones; a shallow perched aquifer and two artesian aquifers (upper and lower). The culinary, industrial, and irrigation water supplies are withdrawn from the lower artesian aquifers.

The groundwater recharge to the aquifer in the vicinity of these communities is primarily from the seepage from rivers, streams, and canals on the perimeters of the basin. More upstream sources of recharge are the same as listed in Table 2 for Delta City. The direction of groundwater movement, as indicated by the water level contours, is from northeast to southwest.

The artesian water in this aquifer is relatively saline (TDS of 500-1000 mg/l) as compared in the aquifer under Delta. The major water quality problem in Hinckley is arsenic, which exceeds EPA's maximum contaminant level (50 micrograms per liter, μg/l) by three times. The arsenic concentrations range from 10 μg/l near Delta to 500 μg/l several miles southwest of Oasis (Kaiserman Associates, 1979). Increasing arsenic concentrations occur in the direction of groundwater movement and with decreasing upper artesian aquifer water levels, indicating that increasing amounts of arsenic are dissolved as the water passes through or over strata containing arsenic bearing compounds. Fluoride is also a possible problem.

V. Garrison

The tiny village of Garrison is in Snake Valley. This large valley near the Nevada border has the largest amount of fresh groundwater in relatively permeable material (about 12 million acre feet in the upper 100 saturated feet) of any valley in the western Utah desert area (Gates, 1980). Water budget information is not available but results of a reconnaissance study suggests that major growth in this valley would have less hydrologic impact than that in any of the other more developed areas included in this report.

MUNICIPAL WATER SYSTEMS

I. Milford City

1. Water Source.

All of Milford's municipal water is pumped from deep wells. The City owns five wells, three of which deliver water to the domestic water system. One other could be used for the domestic system but is currently used only for irrigation of the fair grounds; and from one shallow well only irrigation of the cemetery (March 15 to October 31) is permitted. The existing water rights as well as pump capacities are shown in Table 5. Well and reservoir locations are shown in Figure 5.

2. Current Water Usage.

Milford has historically had one of the highest per capita water use rates in the State of Utah. Two contributing factors are 1) Milford is one of the few Utah cities without metered service connections (a flat rate produces no incentive to conserve) and 2) a high rate of leakage. An

Table 5. Milford City well capacities (Kaiserman, 1978).

Well	Max. Dia.	Depth	Water Right (gpm)	Pump Capacity	Use Permitted
1. City Shed	16"	467'	500	420	Domestic
2. Library Park	18"	468'	450	420	Domestic
3. Jakes Well	14"	504'	763	420	Domestic
4. Ball Park	12"	180'	265	265	Domestic or Irrigation
5. Cemetery	7"	102'	262	262	Irrigation Only
		Total Water Right	2240 gpm		
		Total Culinary Right	1978 gpm		

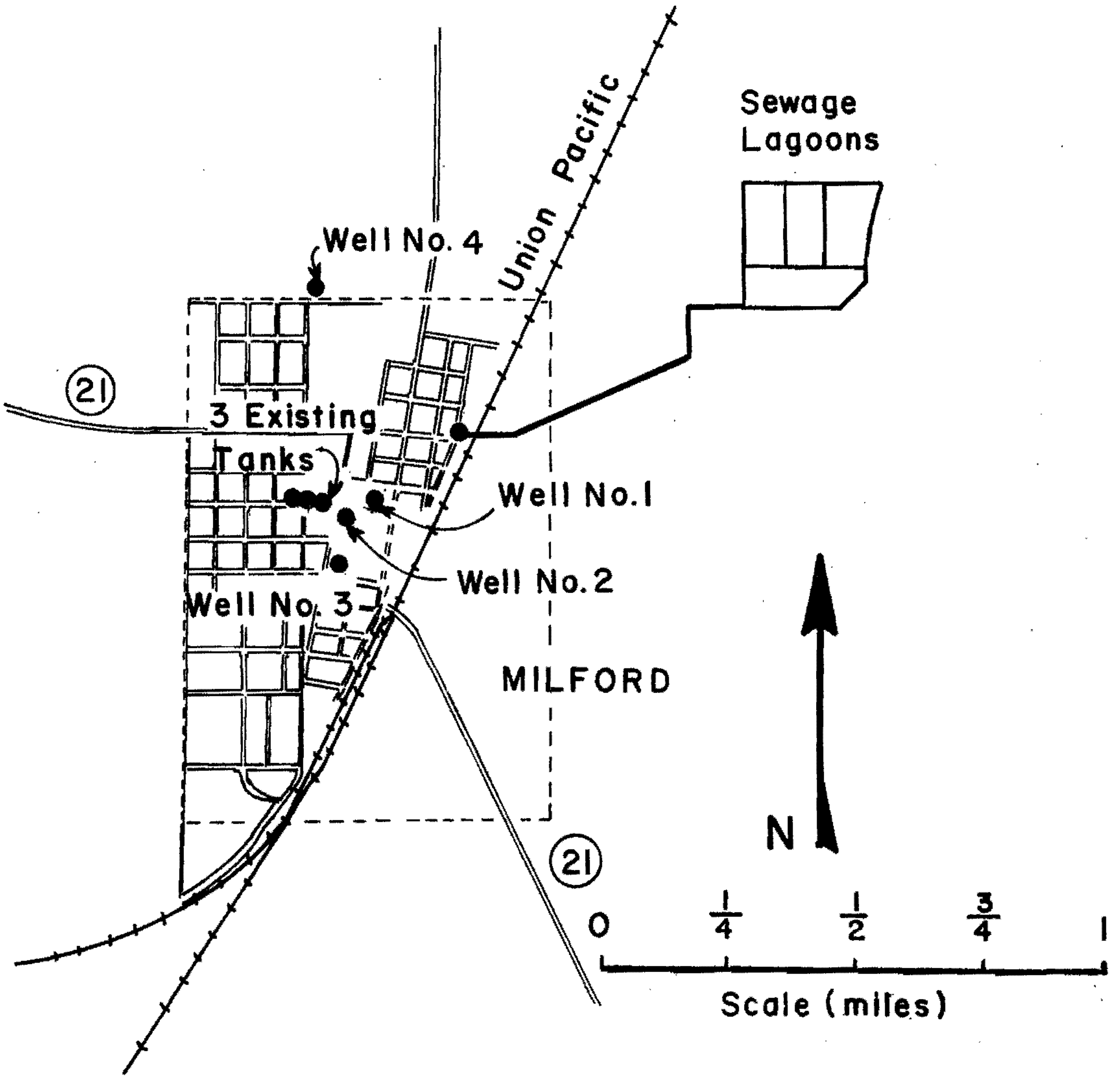

Figure 5. Milford water and sewer system principal facilities location map.

unusually large amount of leakage is caused by a) a corrosive soil which causes rapid deterioration of metal pipe; b) some original pipes still have lead joints, most of which leak, and c) many homes have leaking faucets and toilets. The last situation is directly related to the lack of meters (no economic incentive to repair leaks).

The average and peak month water consumption rates are now approximately 400 and 800 gallons per capita per day (gpcd) respectively. Actual rates have fluctuated from year to year depending upon the extent of leakage control efforts by the city. Use rates are calculated from total volumes of domestic use in Table 6 (not including municipal irrigation uses such as cemetery and fairgrounds but including residential irrigation).

The Kaiserman report does not include historic peak day water use data. This, however, can be estimated from the generalized Utah municipal demand functions developed by Hughes and Gross (1979). Their function relating average to peak day is $D_{pd} = 2.5\ D_{avg} - 50$ where demands are

Table 6. Milford City water consumption (Kaiserman, 1978).

Year	Population	Total (Gal)	Peak Month (Gal)	GPCD Ave.	GPCD Peak
1969	1300	183,865,000	36,626,100	387	939
1970	1304	189,152,200	29,567,800	397	756
1971	1337	196,358,300	32,318,400	402	806
1972	1369	223,825,000	35,605,600	448	867
1973	1402	192,489,800	34,630,000	376	823
1974	1434	221,645,000	34,380,100	423	799
1975	1467	196,878,100	26,789,800	368	609
1976	1500	222,980,800	30,468,700	407	677
Typical	1500	219,000,000	36,000,000	400	800

in gallons per capita per day (gpcd). For the Milford annual average of 400 gpcd, this function gives 950 gpcd. However, the equation was developed with data from metered systems (where constant leakage losses are less), and the resulting estimate is probably too high for Milford. This bias is illustrated by their similar function for peak month of $D_{pm} = 2.43\ D_{avg} - 108$. This equation implies a peak month use of 864 gpcd which is 8 percent higher than the Milford measured quantity of 800. The same 8 percent reduction in the 950 gpcd estimates for the peak day suggests 874 gpcd as the expected value of peak day demand.

3. Maximum Capacity without Changing System.

a. Source and treatment facilities: The groundwater is generally of good quality and the City has no treatment facilities whatever. In recent years, however, several samples with unacceptable colliform counts have resulted in the State Division of Health recommending the addition of a chlorinator to the system. No additional future treatment is anticipated.

Milford's water rights total 1978 gpm which amounts to 85 mg per month compared to the 36 mg estimated for the typical year in Table 2. Obviously the existing water right is more than adequate for future non-MX growth.

The actual production capability of existing pumps (three culinary pumps only since irrigation demand requires the total capacity of the other two pumps during peak summer periods) is 1260 gpm. These pumps will therefore produce only about 54.4 mg during peak months--49 mg if 10 percent down time is allowed for maintenance. This amounts to a 36 percent excess capacity average during a current peak month. However, during peak days (which is the correct time increment for determining pump capacity on a system with adequate equalizing reservoir capacity) the 874 gpcd demand and 10 percent down time for pumps indicates that the 1134 gpm current daily production capacity has 30 percent excess capacity. In other words, a 30 percent growth to a population of 1950 would increase water use to equal existing pumping capacity.

b. Storage: Milford's water storage system consists of three steel tanks as follows:

Reservoir	Capacity (Gal)	Construction Date
1	85,000	1920
2	100,000	1937
3	125,000	1910
Total	310,000	

The reservoirs are all quite old and experience some leakage. The City is currently attempting to finance construction of an additional reservoir. The new Utah Division of Health standard requires 400 gallons of storage per connection for <u>indoor</u> residential use. Since all residential irrigation in Milford is provided from the municipal system, an additional increment of residential storage (assumed to be equal to the indoor requirement) is also required. The total storage requirement for the 460 existing connections at the 800 gallons per connection figure is 368,000 gallons. Finally, consideration must be given to the availability of water for fire fighting. Kaiserman Associates estimate the Milford requirements for fighting a 5-hour fire at 367,500 gallons or 1225 gpm. Since the existing pumps can more than deliver this amount of water and the above storage required could also more than supply it should that be necessary, adequate storage for the present Milford population will be estimated as 368,000 gallons or 16 percent more than is now available.

c. Distribution System: The existing distribution system pipe lengths by size are summarized as follows:

Diameter	Length (ft)
4"	8,000
6"	18,800
8"	10,400
12"	2,200
Fire Hydrants	71 each

Summarizing the capacity of a distribution system is difficult since it has as many capacities as it has locations within the network. The Milford system, nevertheless is generally adequate hydraulically (problems are related to leakage rather than hydraulics) for the current population. The peak instantaneous demand is estimated at 1.8 gpm per connection (Hughes and Gross, 1979) or 828 gpm total for the system. The 12" main line has the capacity to deliver at least 2,000 gpm at a reasonable head loss, and therefore is more than adequate. The 8" lines can deliver about 800 gpm and the 6" lines at least 350 gpm. The central locations of the reservoirs within the distribution network divides the outflow into several different pipes rather quickly, and therefore very substantial growth could be accommodated with no change to the distribution system other than extension of lines to the new areas. The storage and pump capacities are much more limiting than the distribution mains.

4. Hydraulic, Hydrologic, and Economic Implications of Major Growth.

a. Population Projection: Recent population projections for Milford vary over an extremely wide range depending upon the future of a proposed aluminum mining operation (Alunite). For example, the Kaiserman report (1978) recommends water and sewer facilities to handle a population of 6,000 by 1982, the initially scheduled year for full operation by

Alunite. The Five County 208 study projects a lower population limit for 1985 of 1518 (essentially no growth) and an upper limit of 7,278 (with Alunite). Because of a drop in aluminum prices and other economic factors, the Alunite Consortium has now been dissolved, and therefore this major impact will not be included. The population assumptions for this study are:

Year	Population	Situation
1980	1,500	Existing
1987	2,000	4%/yr Growth without MX
1987	14,500	12,500 from MX at construction peak
1995	9,100	6,600 Permanent from MX

b. Projected Water Demand: It would be difficult for Milford to convert to a metered system during normal growth conditions because the existing families would in effect have to pay for the meters with no immediate or apparent benefit. However, if MX related growth is very large and very rapid, it would be very foolish not to meter what would become essentially a major new water system (only about 10 percent of the 1987 population would be associated with the existing system). Therefore the projected water use rates per person will be assumed as identical to existing levels (400 gpcd average and 874 gpcd peak) under the "without MX" scenario but reduced to 290 gpcd average and 674 gpcd peak day with MX. These revised quantities are based upon current use in metered energy impacted areas (many mobile homes) in Utah counties with a similar hot and dry climate. If the cost of water becomes very high due to the expense of developing the large amounts of extra water required, use rates would be substantially lower. An alterate assumption that will be used here is that groundwater will continue to be available at reasonable costs (no treatment other than chlorination) and that federal "impacted area" type subsidies will become available to maintain water prices at a level close to that in non-impacted communities in the region.

The projected water system capacities, supply levels, and water right requirements are shown in Table 7 along with a summary of existing flows and capacities which were discussed previously.

c. Conclusions: The Milford system currently has inadequate reservoir storage, a minor excess capacity of production facilities (wells and pumps), a distribution system which is adequately sized but which experiences considerable leakage, and an established water right to more than double the current peak demands.

If MX is not built (or does not impact the Milford area) the existing system would be adequate in 1987 except for needs to increase storage and peak day pumping capacity. The City is currently proceeding with plans to construct additional storage and drill and equip an additional well to meet these needs.

If, however, the projected MX growth of 12,500 population increase occurs, an almost entirely new system will be required. The distribution system and storage can be provided with no special problems if impacted-area funding is properly administered. The necessary increase in well capacity, however, from 2.85 mgd to 10.7 mgd on peak summer days and the water rights to pump these wells is a different matter. No additional water is available for appropriation in this valley. The groundwater is in fact being mined under present over-appropriated conditions. There is no point in buying local surface water from other users since it would require costly treatment. The only economically feasible method of securing the additional water is to purchase existing groundwater irrigation rights from local farmers and either reduce agricultural production

Table 7. Summary of Milford water system existing and projected capacities.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Present Use	1500 (460 conn.)		(Basis = 400 gpcd Avg and 874 gpcd peak day)		(Basis = 1.8 gpm per conn.)
Average			0.60 mgd		
Peak Day			1.30 mgd	0.31 mg	
Peak Hour					828 gpm
Present Capacity		2240 gpm (Total) 1978 gpm (Residential)	3 ea @ 420 gpm but 90% use factor	Should have 0.37 mg (Basis = 800 gal/conn.--fire flow from pumps)	Basis = 12" Main Line
Average		2.85 mgd	1.63 mgd		
Peak Day		2.85 mgd	1.63 mgd	0.31 mg	
Peak Hour		1978 gpm	1260 gpm		2000 gpm
Required Capacities in 1987 Without MX (Also without any other major impact such as Alunite)	2,000 (613 conn.)		Basis = 400 gpcd avg, 874 gpcd peak, and 90% use factor on peak day	Basis = 55,000 gal fire flow (Balance from wells) Plus 800 gal/conn.	Basis = 1.8 gpm per conn.
Average		0.89 mgd			
Peak Day		1.94 mgd	1.94 mgd	0.55 mg	
Peak Hour			N/A (only daily avg required)		1100 gpm

Table 7. Continued.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Required Capacities 1987 With MX (Without other major impacts)	14,500 (4500 conn.)		Basis = 290 gpcd avg, 674 gpcd peak day and 90% use factor on peak day	Basis = 500 gpm per conn. (minimum landscaping for construction period) fire flow from wells	Basis = 1.7 gpm per conn.
Average		4.2 mgd			
Peak Day		10.7 mgd	10.7 mgd	2.25 mg	
Peak Hour			N/A		7650 gpm

or retire some irrigated land from use. The amount of water allowed by the State Division of Water Rights for irrigation in this area is approximately 4 acre feet annually. However, part of this water returns to the aquifer by deep percolation and is thought to be a major source of groundwater recharge. The State Engineer has therefore taken the position in similar nearby areas that only 2.5 acre feet per acre of land (the estimated depletion fraction of the total diversions) will be allowed to be converted to the new use. This would likely be the ruling in Milford if either conventional sewage treatment or lagoon type treatment (the current approach) is used to treat the municipal wastewater. The full 4 acre feet should be allowed if land application of sewage is used.

Since the most probable sewage treatment method is lagoon containment, 2.5 acre feet per acre of irrigated land will be assumed as the amount of water which can be obtained with a change of use from irrigation to municipal. The change in timing of the pumping should be a benefit rather than a problem. The irrigation use occurs from April to October while the municipal use is spread over all 12 months, thereby decreasing the relative peak period pumping rate from the aquifer.

It will be necessary to acquire an additional 1.35 mgd average flow water right and well production facilities to handle the assumed MX related growth. This amounts to 1516 acre feet per year. Under the assumption outlined above, this will require either removal from production of 606 acres which now have a full water right or reduced yields from a larger acreage--for example 1516 acres if 1.0 a.f./acre can be purchased. These figures are based upon average annual quantities and perhaps understate the problem in regard to summer peaks. Furthermore, the State Engineer would have to approve peak day pumping rates of 10.7 mgd as compared to the 4.2 mgd average rate. The 10.7 mgd amounts to a 16.6 cfs flow rate and the existing wells are pumped at about 1 cfs each. This implies either a large number of similarly sized new wells or a smaller number of very large wells which could cause large local drawdown and interference with existing irrigation wells. It may therefore be necessary to locate the new wells well outside the City boundary and construct long transmission lines; or depending upon the location of purchased irrigation rights--some existing wells may be suitable (after proper grout sealing) for conversion to municipal use. The latter may be more reasonable for water that would only be temporarily needed during MX system construction.

II. Delta City

1. Water Source.

The entire water supply for Delta is groundwater pumped from three currently operating wells. The City has a total water right of 4.255 cfs which has been established from an accumulation of five previously developed wells--two of which are no longer operated. The City's wells and storage tasks are located in Figure 6. The currently operative wells are equipped as follows:

Well	Dia.	Depth	Pump Capacity	Water Right and Use
1. Sugar Factor Well	12"	730'	360 gpm	4.255 cfs Municipal Use (1910 gpm)
2. At Elevated Tank	12"	860'	596 gpm	
3. 3rd W. & Main	20"	856'	1150 gpm	
	Total Capacity		2106 gpm	

2. Current Water Usage.

The population of Delta (Kaiserman Associates, 1979) is estimated at 2,100, and the water system has 775 connections (2.7 persons per connection).

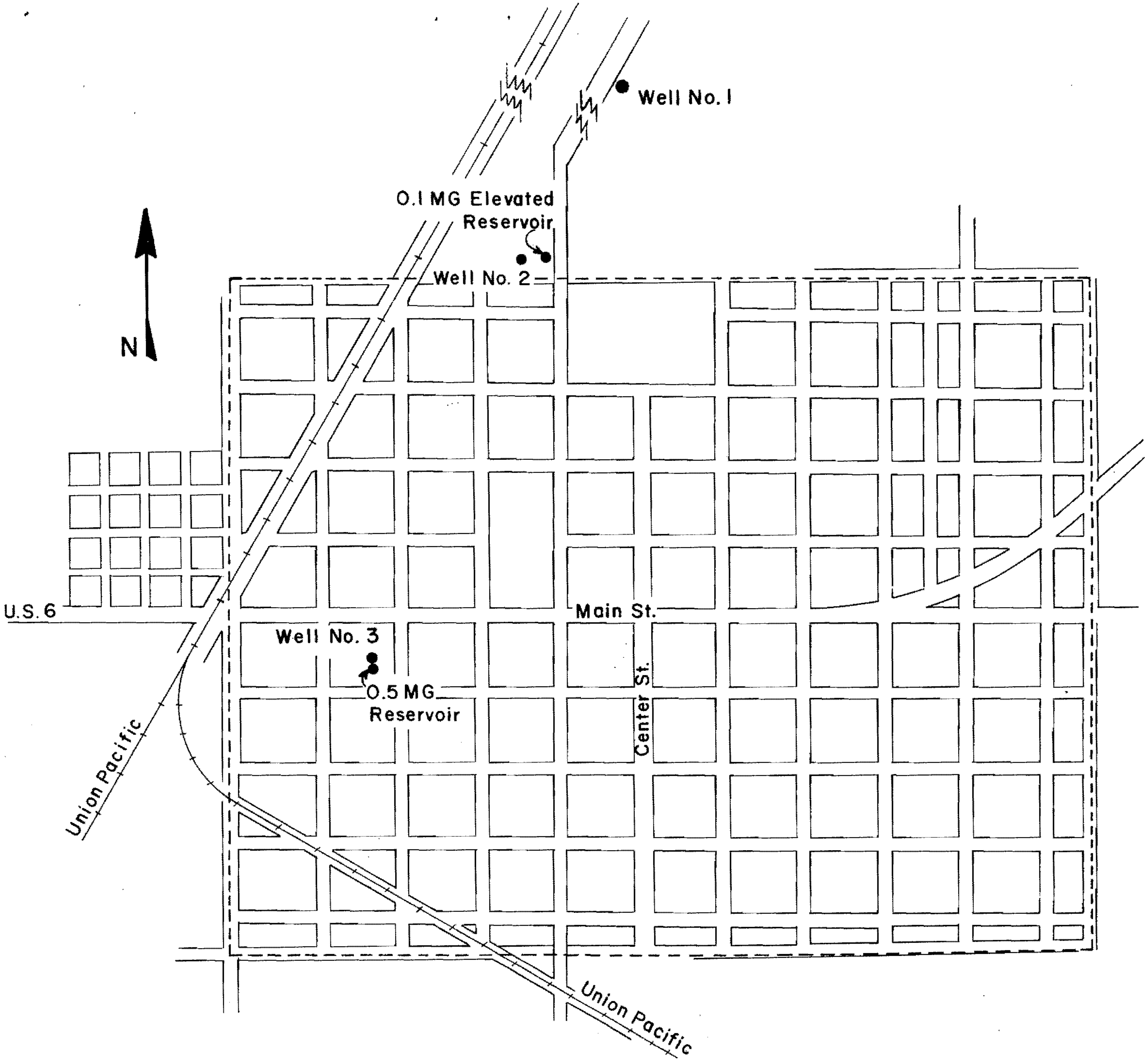

Figure 6. Delta water system well and storage location map.

Recent water use (1976, 1977, and 1978 average) based upon total production from the three wells is given in Table 8. The data indicate daily per capita uses rates (gpcd) of 238 average and 521 during the peak month. The peak day functions of Hughes and Gross (1979) suggests 546 gpcd as a peak day estimate (1.15 mgd for the current population of 2100). This is only slightly greater than the measured peak monthly rate but is considered adequate because the peak month figure in the table is of questionable validity (June rather than the usual July or August peak) and may have resulted from some extraordinary use such as a large fire or line break.

3. Maximum Capacity without Changing System

a. Source and Treatment Facilities: The present groundwater supply is of excellent quality and requires no treatment whatever. No

Table 8. Average 1976-78 water use by Delta City.

	Total (mg)	Daily Average (Gallons)	
		Per Conn.	Per Person
January	7.30	304	113
February	8.79	405	150
March	10.45	435	161
April	16.70	718	266
May	18.21	758	281
June	32.71	1407	521
July	25.52	1062	393
August	23.69	986	365
September	11.22	536	199
October	13.67	588	218
November	4.72	203	75
December	7.23	301	111
Total	180.29		
Average	15.02	642	238

future treatment is anticipated. The existing pump capacities and water rights are detailed in the water source section. The total water right (1910 gpm) is slightly less than the existing total capacity of the pumps (2106 gpm) if all three were operated continuously (which they could not be for any extended period). With a 90 percent use factor, the pump capacity is 1895 gpm or 2.73 mgd, more than twice the amount required by the current peak day demand of 1.15 mg.

b. Storage Facilities: The existing finished water storage consists of an elevated 100,000 gallon steel tank and a ground level 500,000 gallons steel tank. The elevated reservoir maintains the system pressure while the larger tank requires a booster pump for its outflow. The Kaiserman Associates report (1979) recommends a storage capacity of 800 gallons each for 775 connections or 620,000 gallons plus a 2-hour fire flow at 2500 gpm or 300,000 gallons. The total of 920,000 indicates a shortage of 320,000 gal. (35 percent).

c. Distribution System: Kaiserman gives the following summary of distribution pipe line lengths by size:

Diameter	Length	Materials
Under 4"	9,350	
4"	33,800	A Mixture of Cast
6"	23,650	Iron, Asbestos
8"	19,750	Cement and PVC
10"	3,300	
	89,850	

The estimated peak instantaneous flow into the distribution system is 1.8 gpm per connection or 1395 gpm. The separate 10" mains serving each reservoir have a capacity of about 1500 gpm each (3000 gpm total) and the smaller lines appear to be sized with similarly generous capacity the trunk lines in the existing distribution system could thus serve considerable growth.

4. Implications of Major Growth.

a. Population Projection: The population of Delta City has grown 2.2 percent annually during the last decade. Population growth is expected to increase dramatically as the Intermountain Power Project (IPP) is constructed. Superimposing major MX-related growth upon the IPP impact (both of which are scheduled to peak in about 1987) would cause the population to increase more than seven fold in seven years. Since many of the geo-technically suitable MX facility locations are near Delta, a total population of 12,500 (of a statewide total of 30,000) will be assumed to move into the general area of Delta (but not all into Delta City). For estimating the probable impact on water facilities, recent Kaiserman Associates reports on Delta City and the nearby towns of Hinckley, Deseret, Oasis distribute the total IPP population impacts among these towns (see Figure 7 for relative locations). This same distribution (82 percent or 10,250 within Delta) will be used here for the distribution of MX related growth. The resulting population assumptions are as follows:

b. Projected Water Demands: Present per capita water use in Delta (which is completely metered) is below the statewide average. An

Table 9. Projected population for Delta City.

Situation	1980	1987	1995
Growth without IPP and MX	2,100	2,800	
Growth with IPP but without MX	2,100	5,300	
Growth with both IPP and MX	2,100	15,550	10,350

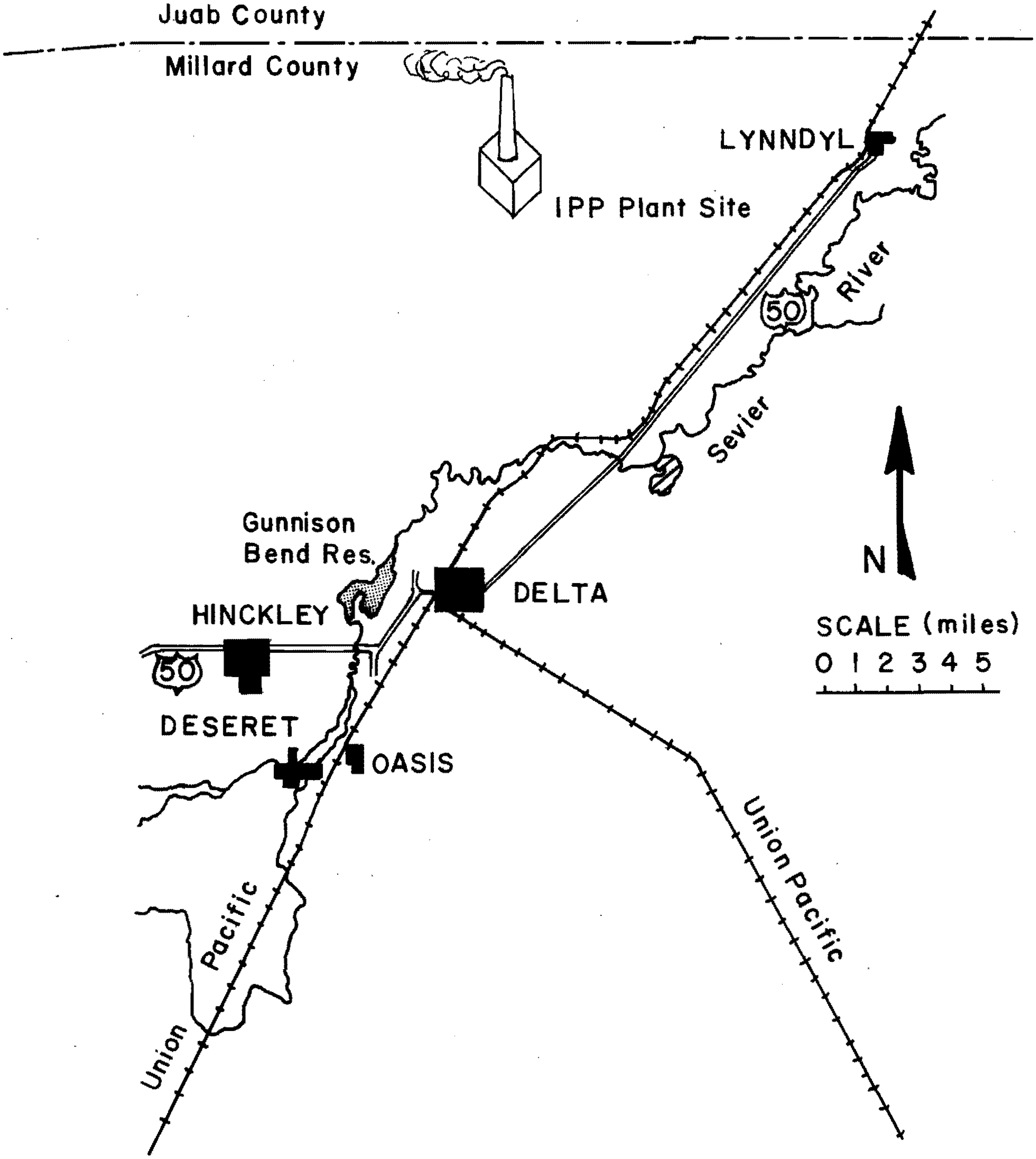

Figure 7. Delta region site map.

even lower use rate may be possible in the future due to increased water charges and to less landscaped area per temporary family during the MX construction period; however, such a decrease is expected to be rather minor and current use levels of 238 gpcd average and 546 gpcd peak will therefore be used for future projections.

c. Conclusions: The Delta water supply system is presently adequate in terms of water rights, deepwell and pump production capacity, and main line distribution system capacity. It has in fact more than 100 percent excess capacity during current peak days. The one inadequacy is in finished water storage. Present storage is adequate for residential and industrial peak period demand but not for fire protection.

The existing system should still be adequate by 1987 assuming IPP is constructed but MX is not (or has no impact upon Delta) in terms of water rights and production facilities. Population growth from 2100 to 5300 will obviously require additions to the distribution network to serve new areas. Whether or not the existing main lines prove adequate depends upon the location of the growth in relation to existing major supply lines. Storage capacity will require an increase from 0.6 mg to 1.5 mg. These projected quantities, along with existing use rates and capacities are summarized in Table 10.

If the 10,250 MX-related population growth is superimposed upon the projected IPP growth in Delta, the existing facilities are entirely inadequate. Delta will be faced with a population expansion from 2100 to 15,550 during a period of 7 years. All of the existing system components will become completely inadequate, and required system expansions will include a 200 percent increase in peak day production, a 400 percent

Table 10. Summary of Delta water system existing and projected capacities.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Present Use (1980)	2100 (775 conn.)		(Basis =238 gpcd avg and 546 gpcd peak day)		Basis = 1.8 gpm per conn. total res. outflow
Average			0.50 mgd		
Peak Day			1.15 mgd	0.60 mg	
Peak Hour			2106 gpm		1395 gpm
Present Capacity (1980)			(Basis = 90% use factor on pumps)	Recommendation = 0.92 mg (Presently 35% shortage)	Basis = (2) ea 10" Mains
Average		2.75 mgd	2.73 mgd		
Peak Day		2.75 mgd	2.73 mgd	0.60 mg	
Peak Hour		1910 gpm	2106 gpm		3,000 gpm
Required Capacities (1987): With IPP, Without MX	5300 (1960 conn.)		Basis = same as present gpcd above and 90% use factor	Basis = 700 gal/conn. Plus 105,000 gal fire flow from res.	Basis = 1.7 gpm per conn.
Average			1.13 mgd		
Peak Day			2.60 mgd	1.5 mg	
Peak Hour			N/A		3330 gpm

Table 10. Continued.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Required Capacities (1987) With Both IPP & MX	15,500 (5770 conn.)		Basis = same as above	Basis = 500 gal/conn. (fire flow from wells)	Basis = 1.6 gpm
Average			3.7 mgd		
Peak Day			8.5 mgd	2.9 mg	
Peak Hour			N/A		9,230 gpm

increase in storage, and a 200 percent increase in main line distribution capacity. These capital investments can be provided in time only with major federal impact type subsidies.

The additional water right requirement on an annual volume basis would be 0.95 mgd or 1070 acre feet per year. Since Delta is in an already over appropriated groundwater basin, the only possible way to acquire this water is to purchase existing rights from irrigated agriculture. The maximum amount per irrigated acre which a holder is allowed to sell is the depletion amount which has been established by the State Engineer at 2.5 A.F./acre. In order to purchase the needed water, either 428 acres will have to be taken completely out of production or some larger number of acres will experience decreased yields (1070 acres for example if farmers were willing to sell 1.0 A.F./acre) because of fractional sales. The second method may be more reasonable for water which can later be returned to agriculture after the MX construction boom.

The well interference impact on the local groundwater aquifer during summer months will be much greater than that implied by the 1157 A.F. of additional average annual pumping by the City. For example, the Delta City total peak day pumping rate would increase from 1.15 mg currently to 8.5 mg (800 to 6040 gpm) by 1987. Existing wells vary from 360 to 1150 gpm capacities each. Therefore several major new wells will be needed, and interference considerations will require that they be located substantial distances outside of the City. The ideal way to avoid legal difficulties with Third-party water users would be to purchase existing wells from irrigators and to continue to pump them near existing pumping rates. There are several difficulties associated with this concept, however, including: 1) irrigation wells usually do not meet the sanitation and gravel packing standards for a good municipal well; 2) the water right purchases may consist of a large number of partial rights from many scattered irrigators, and 3) the irrigation-well owners who are willing to sell their water may be located at long distances from the City.

An additional economic problem related to acquiring rights in Delta is that recent IPP water purchases from farmers in that region have eliminated the "excess" rights held by most farmers and have caused an explosive increase in water costs. Recent IPP purchases were made at $1,750/AF. At this price, 1157 AF would cost Delta City $2 million. The City should be able to find water at a somewhat lower price now that IPP has completed its purchases, but still that recent precedent is bound to maintain an extremely high water cost.

III. Cedar City

1. Water Source.

Cedar City presently obtains its water supply from a combination of 6 wells and 14 springs--locations are given by Figure 8. Two of the wells are very small and are used only for irrigation-spring flow exchanges and therefore aren't shown in Table 11. The city also has purchased water rights to considerable surface water from Coal Creek, which is presently used for irrigation but which could be treated for future culinary use. Cedar City also has a right to 2,000 acre feet annually of water from Kolob Reservoir and is considering expansion of that right to 5,000 a.f. None of the local stream or reservoir water that Cedar City has obtained by purchasing these rights is usable in the culinary system until suitable treatment facilities are installed and a long transmission line is constructed from Kolob Reservoir. Only currently used springs and wells are included in the water rights summary in Table 11.

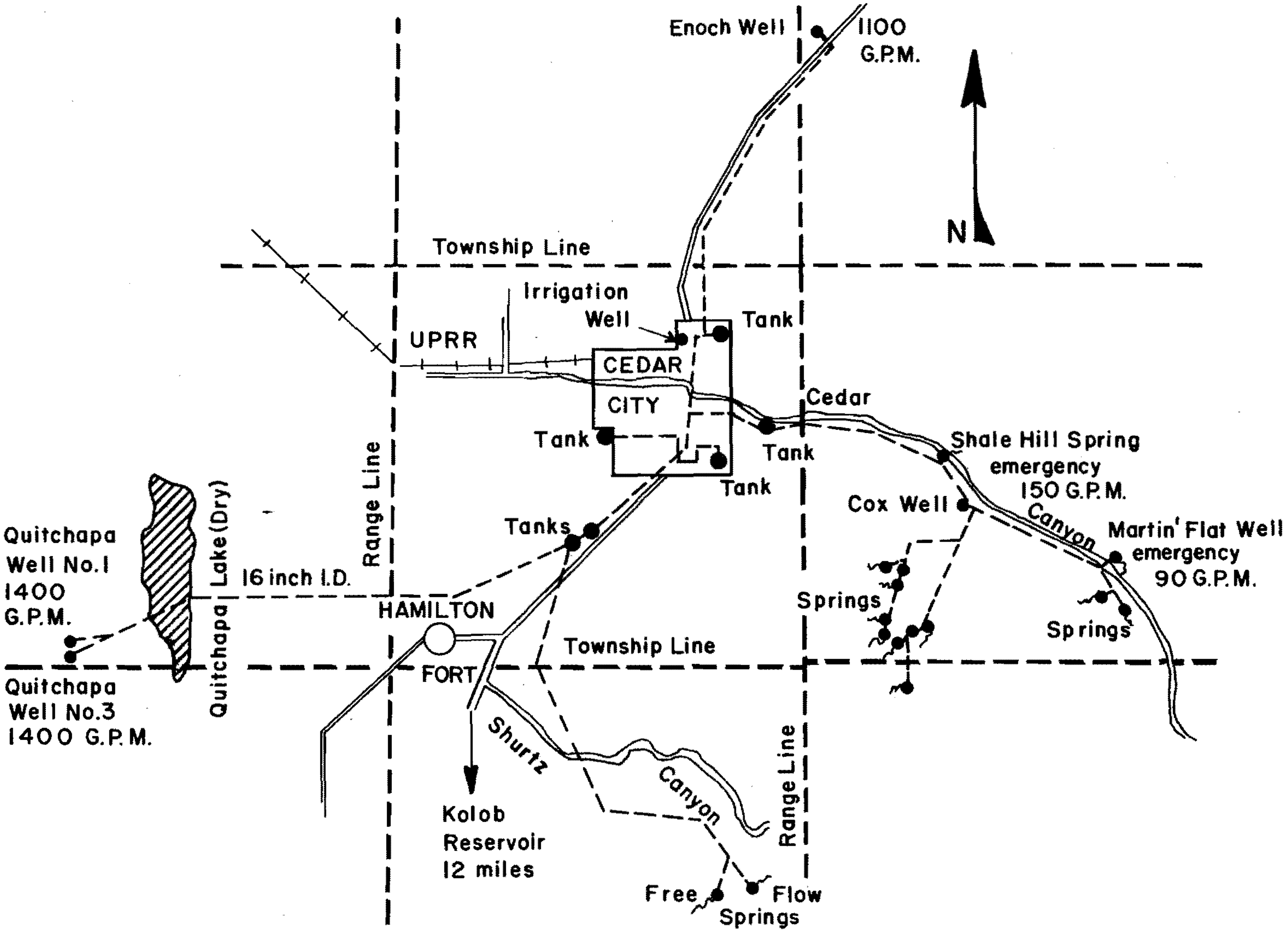

Figure 8. Cedar City existing water system.

Table 11. Cedar City well and spring 1979 production and capacities (Bulloch, 1979).

Facility		Avg. Production (gpm)			Peak Capacity (gpm)	Remarks
		Jan.	July	Yr.		
1. Cedar Canyon Sources		558	788	739	788	12 springs
2. Shurtz Canyon		315	621	467	621	2 Springs
3. Old Enoch Well		0	653	242	1100	5 Miles North of City
4. Quitchapa Well #1		0	356	62	1400	10 Miles SW of City
5. Quitchapa Well #3		166	1217	507	1400	10 Miles SW of City
6. Cemetery Well		0	(933)	(204)	(1700)	Irrigation Only--Quality Unsuitable for Culinary
Culinary Only Totals	(gpm)	1039	3635	2017	5309	
	(mg)	46	162	1057		

The City's water rights combine: 1) "cfs" rights which are either spring or well rights which can be used continuously at the stated flow rate, and 2) "AF" rights which have been mostly acquired from irrigators and therefore are limited to a maximum annual volume. This combination makes characterization of maximum flow rates somewhat ambiguous, but the working assumption for this study will be that the "cfs" rights (which total 7.0 cfs) provide a continuous base flow right upon which the effective "AF" rights (totalling 2,432.3 A.F.) will be superimposed at a constant rate during a 120-day peak summer season. The actual rate of use of the "AF" right could of course be varied to meet demand during unusual peak days as constrained only by pump and transmission capacities.
Using the constant 120-day distribution of "AF" rights, however, gives a maximum water right capacity of 10.2 cfs for a total flow rate of 17.2 cfs or 7723 gpm (Bulloch, undated).

2. Current Water Usage.

The population of Cedar City is estimated at 13,000 for 1979. The City had a total of 3116 water service connections (4.17 persons/conn.). Water use during recent years is summarized in Table 12. The cemetery well was converted from culinary to irrigation purposes during 1976, and total quantities shown after that year do not include production from that well (which is now used for irrigating the cemetery, the college, the high school and the golf course).

The per person annual water use rate is currently 223 gpcd, and the peak day rate is 517 gpcd. The Utah peak day function (Hughes and Gross, 1979) predicts 509 gpcd for the peak day and thus agrees very closely with the measured 1979 rate for Cedar City.

3. Maximum Capacity Without Changing System.

a. Source and Treatment Facilities: The present spring and well water (except for the irrigation well) is of adequate culinary quality

Table 12. Total historic culinary system water use.

Year	No. of Connections	Total Use (mg)	Average Daily Use (gpcd)	Peak Day (mg)
1973	2458	934.5	250	6.2
1974	2567	984.9	252	6.8
1975	2675	953.4	234	6.1
1976	2812	1,037.5	242	6.3
1977	2940	816.2	182	5.3
1978	3015	831.0	181	5.9
1979	3116	1,057.4	223	6.7 (4652 gpm)

without treatment. No future treatment is anticipated until growth requires surface water sources to be introduced into the system. The present peak-period water rights totalling 7723 gpm are substantially greater than the 1979 peak-day demand of 4652 gpm. The existing physical facilities, however, are only able to produce 5309 gpm from the springs and wells, and this amount is only 14 percent more than the 1979 peak demand.

b. Storage Facilities: The finished water storage facilities consist of 7 reservoirs which total 8.5 mg. The residential demand storage recommendation for Cedar City is approximately 700 gallons/conn. or 2.2 mg. Much of the yard irrigation is provided by a separate ditch system and all of the major community irrigated areas (cemetery, college, high school, and golf course) are served by a separate pressure irrigation system. The recommended fire flow is 5.04 mg (10 hour fire @ 3500 gpm). Because of the remote location of the well sources it is desirable to furnish the fire flow (except possibly dependable spring flow) from storage near the distribution system rather than from direct pumping. This indicates a recommended total storage of 7.2 mg. The existing storage therefore represents 18 percent excess capacity.

c. Distribution System: The City Engineer gives the following summary of distribution pipelines by size:

WATER MAINS IN CEDAR CITY LIMITS (FEET)

Size	1977	1978	1979
2"	18,325	18,325	17,945
3"	11,767	11,767	11,767
4"	91,471	92,411	93,248
6"	81,459	93,444	111,454
8"	28,877	29,502	29,972
10"	33,262	33,872	39,262
12"	11,433	11,433	11,433
16"	2,549	2,549	2,549

WATER MAIN OUTSIDE CITY LIMITS

Approximately 36.77 miles

The total peak-hour demand below the reservoirs is estimated at 5600 gpm. This flow enters the city through three major reservoir outlet pipes (north, east, and south of City). Therefore, the single largest pipe flow should not exceed 2000 gpm (which could be handled by a 12" pipe). It appears, therefore, that no hydraulic limitations will be imposed by the principal distribution mains prior to very substantial growth.

4. Hydraulic, Hydrologic, and Economic Impacts of Major Growth.

a. Population Projection: The growth of Cedar City has been very rapid during recent years. The principal impact assumed during most future projections is from the proposed Alunite project. Since that project now appears to be abandoned, the high growth rate used for the area's 208 Plan will not be used here. Rather, the 208 lower growth rate corrected for a 1979 base population of 13,000 will be used. Since most of the suitable locations for MX storage facilities are located closer to Milford and Delta than to Cedar City, only an MX construction period peak population of 5,000 will be assumed. Superimposing this amount on the lower 208 projections gives:

Year	Population	No. of Connections	Situation
1979	13,000	3116	Existing
1987	14,900	3590	Without MX
1987	19,900	5260	With MX (5,000 constr. Peak)
1995	18,940	4730	Permanent MX (2640)

b. Projected Water Demands: The per capita water use in the Cedar City municipal system is currently relatively low compared to that in other Utah communities in such a hot, dry climate. This is partly due to the relatively high cost of water (additional groundwater is not locally available and surface supplies will have to be mostly imported and treated) and to the fact that about 50 percent of the residential gardens and 10 percent of private lawns are served from a separate ditch irrigation system and almost all of the public irrigated areas (the cemetery, college, high school, and golf course) are served from a separate pressure irrigation system. A larger part of the future growth will be in areas not served by the ditch or pressure irrigation systems, and this factor will tend to increase per capita use rates. On the other hand, several factors that will tend to decrease future per capita use include: 1) mobile home residences for many MX construction workers, 2) a general trend toward multiple dwelling units, and 3) a trend toward desert type landscaping which minimizes irrigation. The assumption used here is that these counteracting influences approximately balance and that projected use rates can reasonably be taken at their present values of 223 gpcd average and 517 gpcd on peak day.

c. Conclusions: The Cedar City water supply system is adequate for the existing demand but only by a small margin on peak day (14 percent). By 1987 under normal growth conditions the system will still be adequate except during a few peak days and for distribution laterals serving heavy growth areas. Under this "1987 without MX" situation, 1) the existing water rights appear to be adequate for both average condition (48 percent excess capacity) and peak day condition (25 percent excess capacity), 2) the production facilities total capacity (average annual spring flow plus wells at 90 percent use factor) will be almost double the average demand but an 8 percent shortage will occur during peak days even if wells are pumped 100 percent of the time (a dangerous assumption), 3) the storage capacity should still be adequate but very near the recommended limit. These quantities as well as "with MX" estimates are summarized in Table 13.

The situation for "1987 with MX" is 1) the average flow water rights are adequate but the system is on the borderline of not being able to supply needs during peak periods. The summer 120-day period rights total 11.13 mgd while the peak day requirement (11.23) slightly exceeds this; 2) the capacities of the spring and well system will be adequate for average conditions but not during peak days (a 32 percent shortage); 3) the storage facilities will need to be increased by only 10 percent; and 4) the distribution system will need to be expanded in areas of major growth but existing main lines should require only modest expansion.

Cedar City has adopted a policy of purchasing any water rights which become available in their area. This is obviously a wise policy and has resulted in a capability to handle significant growth (from 13,000 to 20,000 population in this projection) without an emergency type situation. The additions of a treatment plant for surface water from Kolob Reservoir and Cedar Canyon is considered to be a long range future supply (lengthy negotiations and an additional reservoir for an exchange of Kolob water are required). Therefore it is assumed that additional groundwater development (3.59 mgd) will be required to meet MX related demands by 1987. This can likely be accomplished with only two additional wells. The City recently passed a $3 million bond issue for the purpose of doubling the pumping and distribution capacity. Successful completion of that program will result in a system capable of handling the projected MX related growth.

IV. Hinckley, Deseret, and Oasis

1. Water Sources.

These three small communities are located 5 to 6 miles west and south of Delta. Hinckley, population 500, is the only town with a public

Table 13. Summary of Cedar City water system existing and projected capacities.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells & Springs)	Storage (Finished Water)	Distribution System
Present Use (1979)	13,000 (3116 conn.)		(Basis =223 gpcd avg and 517 gpcd peak day)	(7 Reservoirs)	Basis = 1.8 gpm per conn. total res. outflow
Average			2.90 mgd		
Peak Day			6.71 mgd	8.5 mg	
Peak Hour					5600 gpm
Present Capacity (1979)		*Basis = A.F. Type Rights During 120 Days	*(Basis = 1.7 mg springs + 5.0 wells)	(Presently adequate)	Basis = 16" & 12" Mains
Average		6.70 mgd	6.7* mgd		
Peak Day		11.13 mgd*	7.64 mgd	8.5 mg	
Peak Hour		7,728 gpm*	8,913 gpm		9,000 gpm
Required Capacities (1987): Without MX	14,900 (3590 conn.)		Basis = same as present gpcd above and 90% use factor on wells	Basis = 700 gal/conn. Plus 5.5 gal fire flow from res.	Basis = 1.8 gpm per conn.
Average			3.5 mgd		
Peak Day			8.37 mgd	8.0 mg	
Peak Hour			N/A		6462 gpm

Table 13. Continued.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells & Springs)	Storage (Finished Water)	Distribution System
Required Capacities (1987) With MX	19,900 (5260 conn.)		Basis = same as above	Basis = 500 gal/conn. plus 6.0 mg fire flow from res.	Basis = 1.7 gpm
Average			4.74 mgd		
Peak Day			11.23 mgd	9.4 mg	
Peak Hour			N/A		8,940 gpm

water system. Deseret and Oasis, populations 221 and 173, currently have no public system (individual private wells are used). The three communities will be discussed together here in regard to their future water system plans, needs, and MX impacts because of their 1) close proximity, 2) sharing a common groundwater quality problem--arsenic levels which exceed allowable limits, and 3) joint effort underway to construct a regional water system to serve all three communities. Both arsenic levels and the proposed regional well location are shown in Figure 9.

Hinckley has a single well which supplies the municipal system. The water right associated with this well is 0.67 cfs. The well is 12" diameter and 745' deep. In addition to this public water right, some individuals in all three commmunities have private wells with associated private water rights that could be transferred to a regional system. Kaiserman Associates (1979) report these totals as follows:

Water User	Water Rights (cfs)
Hinckley Municipal	0.67
Hinckley Private	2.28
Deseret Private	1.01
Oasis Private	0.80
	4.76 cfs

2. Current Water Usage.

The Hinckley municipal system presently delivers an average of only 107 gpcd and 172 gpcd during peak days. These quantities, however, do not represent the total residential use since many individuals supplement what they purchase with water from private wells. Water usage in Deseret and Oasis is unknown since it is entirely from private wells. Projected water use rates for this region will be based upon the Delta City levels of 238 gpcd avg. and 546 gpcd peak day.

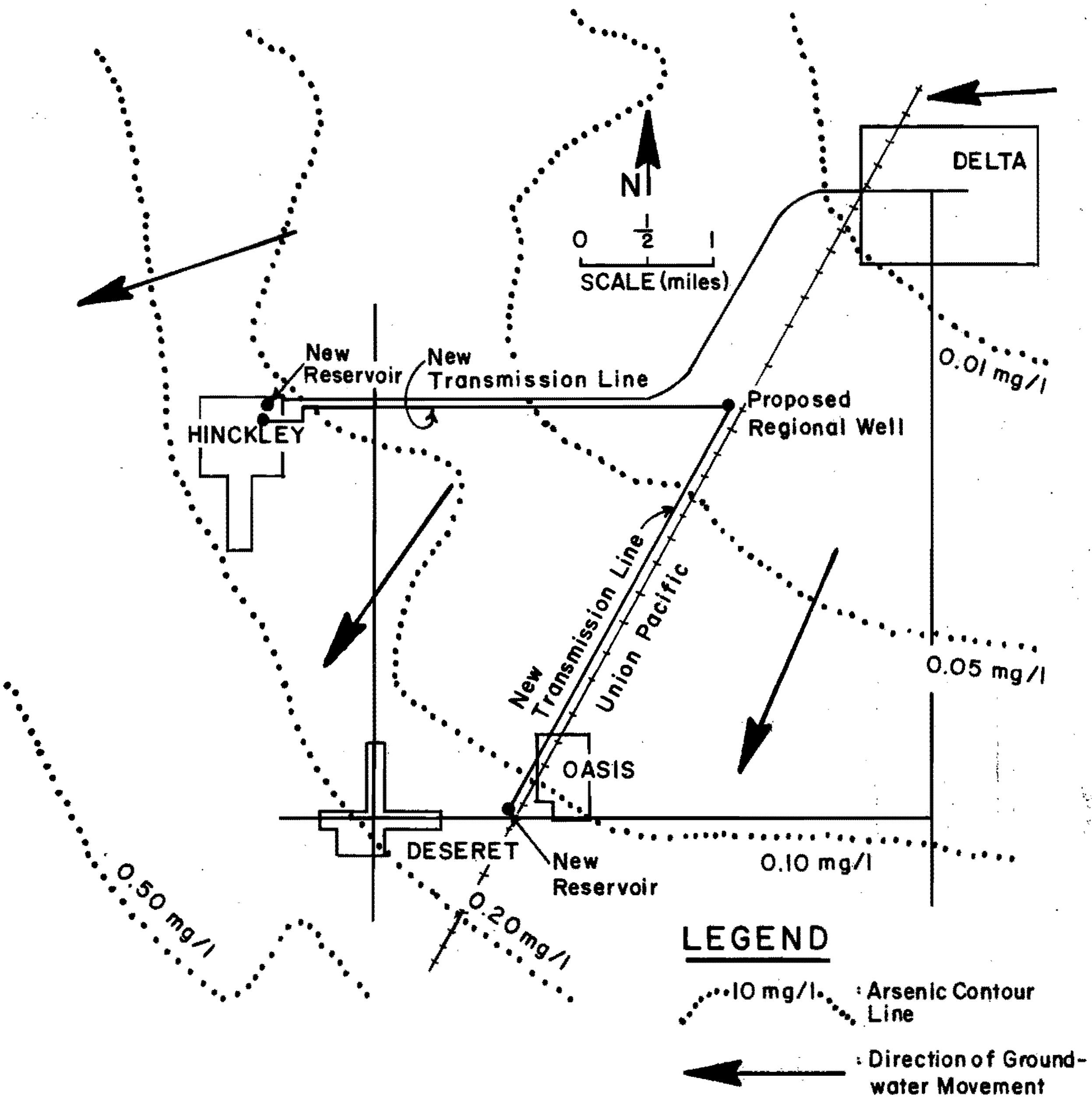

Figure 9. Arsenic levels in groundwater and proposed regional water system.

3. Maximum Capacity Without Changing the System.

The Hinckley municipal well is equipped to pump at a maximum rate of 200 gpm. This facility has hydraulic capacity to serve 1600 persons at current peak day use level of 527 gpcd at projected (Delta City) use levels. However, the well produces water with an arsenic level which has increased from just below the allowable limit of 0.05 mg/l at the time of initial operation in 1967 to over three times that limit (0.16 mg/l) in recent years. It therefore should not be relied upon for future supply without treatment.

The Hinckley storage reservoir is a 100,000-gallon ground level tank with a booster pump. Because the irrigation water in town is supplied by other sytems, the storage requirement is only 400 gal./connection or 60,000 gallons for the 150 existing connections. The recommended fire requirement is 150,000 gallons of which one third can be supplied from wells. If 100,000 gallons of storage are for fire control, the total storage requirement is 160,000 gallons or 60,000 gallons more than currently available.

The distribution network consists of 6" and 4" pipes except for smaller lines serving isolated families without fire protection. The 6" main line capacity is approximately 500 gpm (PVC pipe). Which is considerably more than existing peak demand except during a major fire.

4. Implication of Major Growth.

a. Population Projection: Both IPP and MX will have substantial impact on this region (both of which are assumed to peak in 1987). The assumption used here will be that 18 percent of the population growth in the region will occur in the tri-city area while the balance will occur in Delta. Kaiserman Associates (1979) projections are used for the non-MX growth with the results shown in Table 14.

b. Conclusions: The existing Hinckley system and projected three-community capacity requirements are summarized in Table 15. The existing distribution system and storage reservoir in Hinckley will be usable, but will both require major expansion for MX and IPP related growth.

The Kaiserman Associates report discusses the problem caused by naturally occurring arsenic and suggests increasing production from the existing well and treating the water to remove arsenic. This alternative, however, is more expensive than developing a new regional well north of the three communities (in a low arsenic area) and constructing transmission lines to the three service zones. It will be assumed therefore that the existing Hinckley well will be maintained only for standby emergency operation and that a new regional well or wells of 1500 gpm capacity will be constructed. A new 3.6-mile transmission line to Hinckley and 3.4-mile line to a Deseret/Oasis reservoir will then be required. Complete new distribution systems (8" maximum diameter) and a 0.62 mg storage reservoir will be required to serve Deseret and Oasis.

Table 14. Projected population for the Hinckley-Deseret-Oasis area.

Situations	1980	1987	1995
Growth without IPP and MX (Kaiserman)	925	1050	1160
Growth with IPP but without MX (Kaiserman)	925	1600	1410
Growth with IPP and MX	925	4000	2700

Table 15. Summary of Hinckley existing water system and projected Hinckley, Deseret, and Oasis capacity requirements.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Present Use (1980)	500 (Hinckley only) (152 conn.)		(Basis =107 gpcd avg and 172 gpcd peak day)		Basis = 1.8 gpm per conn. total res. outflow
Average			0.05 mgd		
Peak Day			0.09 mgd	0.10 mg	
Peak Hour			200 gpm		274 gpm
Present Capacity (1980)		Basis - Hinckley Municipal Only	(Basis = 90% use factor on pumps)	Recommendation = 0.16 mg (Presently 35% shortage)	Basis = 6" Main
Average		0.43 mgd	0.26 mgd		
Peak Day		0.43 mgd	0.26 mgd	0.10 mg	
Peak Hour		300 gpm	200 gpm		500 gpm
Required Capacities (1987): With IPP, Without MX	(All three communities) (490 conn.) 1600 population		Basis = 238 gpcd avg and 546 peak (90% use factor)	Basis = 600 gal/conn. Plus 0.9 mg gal fire flow from res.	Basis = 1.8 gpm per conn.
Average			0.38 mgd		
Peak Day			0.87 mgd	1.2 mg	
Peak Hour			N/A		882 gpm

Table 15. Continued.

Item	Population & Number of Connections	Water Rights	Production Facilities (Culinary Wells Only)	Storage (Finished Water)	Distribution System
Required Capacities (1987) With Both IPP & MX	4,000 persons (1220 conn.)		Basis = same as above	Basis = 600 gal/conn. (fire flow from wells)	Basis = 1.7 gpm per conn.
Average			0.95 mgd		
Peak Day			2.18 mgd	1.40 mg	
Peak Hour			N/A		2,074 gpm

No additional water rights will be required <u>if</u> sufficient individual rights now owned by users in the three communities can be acquired by the regional utility. It will be necessary to acquire 0.80 cfs of such rights (only 20 percent of the existing individual well rights in the three communities).

V. Garrison

The 60 people (approximately 15 families) of Garrison, located in Snake Valley near the Utah-Nevada border, have no public water system. Private wells are used for residential water supply.

This area, however, has good potential for groundwater development. Contrary to the situation in the more densely populated valleys further east, the Snake Valley has groundwater in substantial amounts available for appropriation without decreasing agricultural production. The quantities required to support MX related growth could likely be obtained in this area with much less impact to existing water users than in the Delta, Milford, or Cedar City areas. For example, if one half of the 30,000 Utah MX construction induced population increase occurred in this region, the annual municipal water demand (at 230 gpcd) would be 1260 mg or 3,880 acre feet. The peak day pumping capacity (at 526 gpcd) would be 5,480 gpm and could be readily supplied by four wells of 1400 gpm capacity which, if properly located, would have no adverse hydrologic impact on the aquifer.

Of course since no municipal water system now exists in the area, all wells, storage reservoirs, and distribution pipes would have to be built from scratch. This would require substantial investment. Furthermore, there is no existing institution to take charge of the expansion. All necessary design and implementation would have to be done through the MX project.

WASTEWATER SYSTEMS

I. Milford City

1. Existing Collection and Treatment Systems.

a. Collection System: Kaiserman Associates (January 1978) prepared preliminary water, sewer, and storm drain plans for Milford City. The entire city, with few exceptions, is served by the existing sewer collection system summarized in Table 16. The lines are vitrified clay type with oakum and/or mortar joints. The pipe seems to be in fair condition. The joints are in poor conditions, and many are penetrated by roots.

Some of the sewers were constructed over 100 years ago. The existing collection system violates several present Utah Division of Health Code of Water Disposal Regulations. Violations include mainlines constructed on inadequate grades (0.0106 percent), cracking and material breakdown of the sewer lines, and undersized lines causing congestion and clogging in the system. According to the Utah State Division of Health Regulation, the existing sewer collection system requires rehabilitation.

The system has no industrial contributors and consists entirely of household, commercial, and public connections. It serves approximately 460 connections with a population of 1500 (3.2 persons per connection).

Table 16. Existing sewer collection system (Kaiserman, 1978).

5,000 L.F. of 15" sewer pipe	13,500 L.F. of 6" sewer pipe
5,400 L.F. of 10" sewer pipe	8,900 L.F. of 4" sewer pipe
5,000 L.F. of 8" sewer pipe	44 manholes

The average daily flow is 171,700 gallons which is equivalent to 117 gallons per capita per day (gpcd). This is slightly higher than normal, probably due to excessive water use because the community does not use water meters. The average annual maximum is estimated at 155 gallons per minute and the average minimum daily dry weather flow is estimated at 75 gallons per minute. The sewer system is primarily a sanitary system; however, at least one catch basin is connected to the collection system and it is suspected that other storm drain structures are connected. Because of the low average annual precipitation (8.4 inches) storm water has not caused significant problems.

A conservative estimate of infiltration/inflow to the system is 70 gallons per minute (gpm). It was estimated that 60 percent of the infiltration inflow to the Milford sewers is from leaky residential water connections (leaky sinks and toilets). The remaining 40 percent is probably from water lines through broken sewerline joints. Groundwater infiltration is not significant because the water level is at least 40 feet deep.

b. Existing Lift Station: Milford has one lift station. The station is designed with a wet well, chlorination room, and pumper room. Two 7.5-horsepower submersible sewerage pumps delivered up to 300 gpm through approximately 3600 feet of 6 inch diameter force main to the stabilization ponds. These pumps are working near design capacity due to the excessive inflow and improperly operating check valves in the force main.

c. Existing Wastewater Treatment System: Presently Milford pumps its sewerage to total containment lagoons approximately 3600 feet east of the town. The lagoons are designed to accommodate an influent from a design population of 2,000 and a flow of 240,000 gallons per day (167 gpm or 120 gpcd). The lagoon has four cells operated in series (Table 17). The total lagoon area is 34.4 acres. The lagoon was sized based on a net annual evaporation (evaporation minus precipitation) of 39.5 inches, and a daily percolation rate of 0.005 inches.

Complete containment lagoons were installed because of the high net evaporation rate, the relatively inexpensive land, restrictive surface water discharge standards (Table 18), and low technology operating requirements. Requirements for Class "C" and "D" waters are shown in Appendix A--pages V-13 through V-16 in Kaiserman (1978).

d. Existing Storm Water System: Storm water runoff is not a problem at this time. As is typical along desert basin margins, the

Table 17. Milford complete containment lagoon.

Cell Number 1: Primary Pond 10.1 acres
Cell Number 2: 8.5 acres
Cell Number 3: 7.9 acres
Cell Number 4: 7.9 acres
Average Depth Equals 5 Feet

Table 18. Summary of discharge standards.

Type of Discharge	Level of Treatment
Surface Water	Meet polished secondary treatment and maintain Class "C" standards in receiving streams
Irrigation - confined	Class "D" water standards
Irrigation - unconfined	Polished secondary treatment

little rainfall (8.4 inches per year) produces little runoff. That which occurs is sheet-flow which quickly infiltrates into the permeable soil on mild slopes. These conditions also minimize the impact of runoff from the surrounding drainage areas on Milford.

2. Maximum Capacity Without Changing System.

The present sewage collection system does not meet state standards for the existing population. The existing pump station was designed to support a population of 1650 (250 gpcd peak design flow). Any significant increase in the population would require larger sized pumps, larger wet wells, and an enlarged force main. The present lagoon system is designed for a population of 2000 and a flow of 0.24 mgd.

3. Implications of Major Growth.

The population impact due to MX was given in the Milford water system section. It is anticipated that major residential growth would take place north and west of Milford. Completely new sewer collection systems would be required for the new areas, and major portions of the existing system would need to be replaced. New lift stations capable of pumping 1.6 mgd would be required. This flow is based on 120 gpcd and a projected population of 13,500.

Kaiserman (1978) recommended a design seepage rate of 0.125 inches per day (3.8 feet per year) for lagoon design rather than the 0.005 inches per day (0.2 feet per year) used previously. Based on this assumption a complete containment lagoon area of 256 acres would be required to support a population of 13,500 with 120 gpcd flow. Assuming an organic loading of 0.17 pounds BOD per capita day and a maximum loading rate to the primary cell of 40 pounds BOD per day per acre, total primary cell area should not be less than 57 acres.

Most new residential development is expected to take place north and west of town. The natural drainage pattern would direct any storm runoff from this area through town. Proper design is required to provide grading and curbs and gutters that route surface runoff into uninhibitated areas with high soil permeability.

Conclusions: The present Milford sewer collection system is inadequate because of design deficiencies, cracking and material breakdown of the sewerlines, and undersized lines causing congestion and clogging. The projected MX growth would cause a six-fold increase in population by 1987. Flow would increase from 0.24 mgd to 1.6 mgd. A completely new sewer collection system would be required for the new population, and major modifications would be needed to upgrade the current system. Depending on the location of new lagoons, new lift stations would be required to pump 1.6 mgd. Kaiserman (January 1978) recommends that increases in storm water runoff due to expansion of the community be routed around town to infiltration areas by a system of surface canals, culverts and detention ponds.

Over 200 additional acres of lagoons will be required to completely contain the wastewater that would be associated with construction of the MX system. A summry of the Milford wastewater system existing and projected capacities is in Table 19.

Table 19. Summary of Milford wastewater existing and projected capacities.

Item	Population and Number of Connections	Collection System	Treatment System	Storm Water
Present Use	1,500 (460 connections)	Essentially complete sanitary sewer with vitrified clay pipe and oakum and/or motor joints. Substandard. condition. One pump . station of adequate capacity. Maximum daily flow of 160 gpm.	One four cell complete containment lagoon of 34.4 total acres. Design based on an average net evaporation and seepage loss of 3.5 feet per year. Organic load = 0.17 pounds BOD per capita day. Maximum organic load to primary cell not to exceed 40 pounds BOD per acre.	The area only receives about 8 inches of rain per year. Surface drainage is adequate.
Present Capacity	1,650 (500 connections)	The present collection system is operating a capacity. The pump station can support a population of 1650 (230 gpcd peak design flow).	The present lagoon system is designed for a population of 2000 and a flow of 0.24 MGD (120 gpcd).	Surface drainage is adequate.
Required Capacity in 1987 Without MX	2,000 (613 connections)	New collector pipes and modifications to the lift station.	The present lagoon is adequate.	Proper design of new structures to route surface flows.
Required Capacity in 1987 with MX	14,500 (4500 connections)	New collector system and replacement of major portions of existing systems. Completely new pump stations.	A total requirement of 256 acres including 57 acres of primary cells. Based on 3.3 feet per year net evaporation and 3.8 feet per year seepage (1/8 inch per day).	Proper grading to properly route surface runoff around town.

II. Delta City

1. Existing Collection and Treatment Systems.

a. Collection system: Kaiserman Associates Inc. (September 1979) conducted a study for the City of Delta to identify problems within the existing water, sewer, and storm drain utility systems, and to develop solutions to facilitate projected growth. The detailed information on the existing water and sewer systems of Delta was provided by studies and final engineering designs prepared by Call Engineering.

The present collection system is comprised of vitrified clay pipe, some with oakum joints and some with open joints. Sections of asbestos concrete (particularly for the larger sizes) and PVC pipe have recently been added. Presently the collection system consists of nearly 8.5 miles of pipe and 90 manholes (see Table 20). The lines serve approximately 775 connections, with an average 2.71 persons per connection. No storm drains directly enter the sewage collection system.

Table 20. Present sewer collection system for Delta, Utah.

Length (ft)	Pipe Size (in)	Material	Allowable Infiltration[a] (GPC)
950	6	V.C.	1,620
28,100	8	V.C., A.C., PVC	63,900
9,100	10	V.C., A.C.	25,860
4,150	12	A.C.	14,160
2,400	15	A.C.	10,230
Total 44,700			

[a] EPA standards allow 1500 gpd/inch diameter/mile of pipe.

Delta presently produces an average daily wastewater flow throughout the year of 0.397 mgd (187 gallons per capita day). The peak daily flow is nearly 400 gpm. A high water table contributes to an estimated infiltration rate of 90 gpcd which exceeds the EPA allowable infiltration rate standard of 55 gpcd. Table 21 shows the monthly average sewage flow for the period 1975-1977 (Kaiserman, 1979).

Table 21 indicates that maximum flows occur during the summer when irrigation raises the water table and increases infiltration. Low flows occur in February, but even then a flow as high as 143 gpcd indicates some "dry weather" infiltration.

Although most of the sewage flow is gravity-flow, the flat topography necessitates three lift stations designated A, B, and C. Stations A and C are intermediate stations which provide sufficient elevations for gravity

Table 21. Monthly average sewage flows for Delta (1975-1979).

Month	mgd	gpcd
October	0.368	173
November	0.350	164
December	0.349	164
January	0.319	150
February	0.305	143
March	0.326	153
April	0.330	155
May	0.410	192
June	0.479	225
July	0.541	254
August	0.569	267
September	0.423	198
Average	0.397	187

lines to feed station B which pumps the total city load through a 10" force main 7900 feet to the treatment lagoon south of town. The characteristics of the pump stations are shown in Table 22. Backup diesel power generation equipment has been installed at lift stations A and B.

b. Sewage Treatment Facility: The City of Delta utilizes a detention (stabilization) lagoon system constructed in 1971. Water elevation control stations are located between the six cells of the lagoon system. Table 23 shows the characteristics of the system.

The detention lagoon was designed to accommodate the waste load for a design population of 3500 people plus an anticipated industrial

Table 22. Sewage pump stations.

Pump Station	Pump	Capacity	Load (gpm)	Comment
A	Two alternate-operating 5.0 HP lift pumps	Each pump has a capacity of 575 gpm against 18 feet of head	235 (ave month) 335 (peak month) 416 (peak day)	Chlorination
B	Two alternate-operating 9.4 HP pumps	Each pump has a capacity of 550 gpm against 35 feet of head	276 (ave month) 395 (peak month) 490 (peak day)	
C	Two alternate-operating 5 HP pumps	Each pump has a capacity of 550 gpm against 12 feet of head	41 (ave month) 59 (peak month) 74 (peak day)	

Table 23. Wastewater stabilization lagoon.

Cell	Maximum Water Surface Area (acres)	Total Capacity When Full (acre feet)
Primary	20.0	56.8
2	8.3	39.4
3	8.3	39.4
4	8.0	37.0
5	8.3	39.4
6	8.3	39.4
Total	61.2	251.4

BOD load of 200 pounds/day. A hydraulic flow of 150 gpcd and a domestic BOD load of 0.17 pounds per capita per day were assumed. The system was designed to detain an average waste flow of 0.525 mgd for 150 days before discharging it to a nearby irrigation canal.

To date only the first three cells of the lagoon system have ever approached capacity and no effluent has ever been released. Consequently, under current loading conditions the system is operating as a complete containment lagoon. Water losses from the three ponds approach 12.2 feet per year. Assuming net evaporation loss to be 3.9 feet per year (47 inches per year) then seepage losses amount to 8.3 feet per year (98 inches per year). Kaiserman (1979) recommends that this substantial seepage rate be considered to avoid oversizing in future lagoon design. The maximum recommended seepage rate by Utah State standards is 0.25 inches per day (91 inches per year) and this seepage rate will be assumed for calculations in this report.

The existing detention pond system has experienced a few operational problems. The diking has shown some signs of slow deterioration due to erosion and wave action. The ponds have produced foul odors during the spring "overturn" in March and April. Flow meters were vandalized, so no flow data are available.

Revenues to operate and maintain the sewerage system are generated by connection fees and assessment of a monthly service charge as shown in Table 24.

No integrated storm drain system presently exists in Delta. The municipal irrigation network throughout Delta captures much of the storm runoff and transports it to low-lying agricultural fields within the city limits. The general lack of topographical relief in the study area attenuates flood flows and reduces erosion. Infiltration rates are relatively slow (0.02 to 0.60 inches per hour) within Delta and contribute to the tendency for rain water to pond in certain areas. Delta does not receive measurable runoff from upland slopes located outside the city limits.

2. Maximum Capacity Without Changing the System.

The existing wastewater collection system and lift stations are adequate for the present population. However, a program should be implemented to clean all collection lines on a five-year rotating basis.

Table 24. Fees for wastewater service.

Type of Fee	Cost ($)
Connection Fee (50 feet of main with a 4 inch connector)	250.
Monthly Fee - Residential	3.
Monthly Fee - Commercial	3. to 10.

The existing facilities at lift station A are large enough to serve all development within the present service area and an additional 50 acres south of the lift station. Lift station C presently pumps a small portion of the total flow from Delta and is also more than adequate. Lift station B is pumping a peak daily flow of about 400 gpm and serving the entire population of Delta. A large portion of this flow is infiltration and, therefore, flows will not increase in direct proportion to population growth if the new sewer lines are designed and installed to minimize infiltration. Assuming a flow of 140 gpcd and an excess capacity of 50 gpm at station B, the existing stations could accommodate a population increase of about 500 people to a new total population of 2600.

The existing lagoon system is more than adequate to support the population that could be serviced by the existing collection and lift stations.

3. Implications of Major Growth.

New sewer collection systems and pump stations will be required to support new growth. The design of these installations will depend on the locations within the community where the growth occurs.

The excess capacity in the existing lagoon should be utilized when the population of the town reaches a point where complete containment of the waste is no longer possible. In order to do so, Delta must obtain a NPDES permit to discharge lagoon effluent to the irrigation canal as planned. Detention ponds generally do not achieve sufficient removal to meet "Polished Secondary" effluent standards. Reynolds et al. (1977), have demonstrated the feasibility of using intermittent sand filters to polish stabilization pond effluent. Intermittent dosing and resting of the filter maintains aerobic conditions in the surface layers, allowing for further oxidation of the waste load and minimizing clogging of the filter.

Intermittent sand filters are usually loaded hydraulically once a day during a four to six hour period. When a single dose to a filter will not percolate through it within the remaining 18-20 hours of the day it is considered plugged, and the filter sand needs to be reconditioned or removed. Periodic reconditioning of the filter surface may be accomplished by raking, scraping, or washing the top 2-3 inches of sand. If the sand is removed, it may serve as an excellent soil conditioner.

A maximum intermittent sand filter surface area of approximately 0.6 acres would be required to accept a surface hydraulic loading of 0.4 million gallons per acre per day (mgad) because 25 percent of the surface area needs to be considered as being dewatered for cleaning.

Bed depth would be 2-3 feet, and an underdrain system should be provided beneath each filter. Techniques have been developed to minimize freezing problems related to filter operation during the winter.

Effluent provided from the filter, if operated and maintained properly, should meet the 1985 requirements of 15 mg/l BOD and 10 mg/l suspended solids. Chlorination facilities would also be required to chlorinate the effluent prior to release to a receiving water. Probably the two most cost effective techniques for treating the wastewater from Delta would be complete containment or a stabilization lagoon followed by intermittent sand filtration.

a. Complete Containment: Kaiserman (1979) estimated that if the new sewer lines were installed properly, the average flow would be approximately 130 gpcd. Assuming a net evaporation rate of 3.9 feet per year and seepage losses of 8.2 feet per year, 64 acres of lagoon area would be required to service the projected population of 5300 associated with the IPP project. Based on the same assumptions, 187 acres would be required to support the projected 15,550 population associated with both the IPP and MX projects.

b. Detention Pond With Intermittent Sand Filtration: State regulations limit the waste load sent to the primary pond to 40 pounds per acre per day to avoid odor problems. State regulations also require a 120-day detention period. Based on these standards, a lagoon area of 56 acres would be required for a population of 5300. Assuming a filter loading rate of 0.4 million gallons per acre per day, 2 acres of filter area would be required to support the population. Based on the same standards, 164 acres of lagoon and 7 acres of intermittent sand filter would be required for a population of 15,550 people. A summary is included in Table 25.

Extensive storm drain systems are not recommended for Delta because of its arid climate. New commercial and higher density residential developments in eastern Delta should be provided with storm flow facilities such as curbs, gutters, and waterways to transport surface runoff to strategically placed enclosed pipe storm drains. These can discharge into existing drains and irrigation canals that carry the water out of the city where it can infiltrate on undeveloped land.

Table 25. Summary of Delta wastewater existing and projected capacities.

Item	Population and Number of Connections	Collection System	Treatment System	Storm Water
Present Use (1980)	2100 (775 connections)	Essentially complete sanitary sewer with vitrified clay pipe having oakum or "open" joints. Adequate condition. Three pump stations of adequate capacity. Average monthly flow rate of 276 gpm (190 gpcd). The peak monthly flow rate of 335 gpm (229 gpcd) is reached during irrigation season.	One six-cell detention lagoon of 61 total area. Design based on 120 day detention and an organic load of 0.17 pounds BOD per capita day. Due to high actual evaporation and seepage rates the pond is presently functioning as a complete containment lagoon.	The area only receives about 8 inches of rain per year. Surface drainage is adequate.
Present Capacity	2400 (890 connections)	The capacity of the system is limited by the capacity of the collection sewers and the capacity of pump station B.	Due to the high evaporation and seepage rates, the present lagoon system is more than adequate to function as a complete containment lagoon for the existing sewer collection system.	Existing conditions are adequate. New and more dense residential and commercial developments should be provided with adequate surface drainage facilities such as curbs, gutters and waterways.

Table 25. Continued.

Item	Population and Number of Connections	Collection System	Treatment System	Storm Water
Required Capacities (1987): With IPP, Without MX	5300 (1960 connections)	New sewer collection systems and pump stations would be required to serve the new development.	A complete containment lagoon for this population would require 64 acres which is only slightly more (3) acres than is currently available. The existing lagoon might function adequately at the 5% overload caused by not expanding an additional 3 acres.	Existing conditions are adequate. New and more dense residential and commercial development should be provided with adequate surface drainage facilities such as curbs, gutters and water ways.
Required Capacities (1987): With Both IPP and MX	15,550 (5900 connections)	New sewer collection systems and pump stations would be required to serve the new development. Assuming new lines are installed properly to prevent infiltration, the estimated average monthly flow would be 2.6 MGD (130 gpcd).	A complete containment lagoon for this population would require 187 acres of lagoon area. Conventional design of a detention lagoon followed by intermittent sand filtration would require a lagoon of 164 acres and 7 acres of sand filters. If 12.1 feet per year were allowed for seepage and net evaporation, the lagoon area would be 117 acres and the sand filter area of 2 acres.	Existing conditions are adequate. New and more dense residential and commercial development should be provided with adequate surface drainage facilities such as curbs, gutters and water ways.

III. Cedar City

1. Existing Collection and Treatment System.

Cedar City is the largest community covered in this study, but because of its greater distance from the proposed MX construction sites the population growth projections indicate that it may receive the smallest percentage population increase.

The sewage collection lines were constructed early in the 1930s and later expanded as needed (208 WQMP, 1977). In 1949 additional lines were installed, and an Imhoff tank was constructed for sewage treatment. The effluent from the Imhoff tank was used for irrigation. There are no reported high groundwater levels in Cedar City. As a result, there are no infiltration problems. Measurements taken in 1970 indicate an average daily flow of approximately 100 gallons per capita day (208 WQMP).

In order to upgrade the quality of the effluent and meet current water quality standards, a new treatment plant was constructed and went into operation in December 1977. The plant consists of a 100-foot diameter primary trickling filter; an 80-foot diameter secondary trickling filter; primary, intermediate, and final clarification; two 12-foot diameter microfloc, gravity-flow, mixed media filters; and two 50-foot diameter sludge digesters. Effluent from the sand filters discharges to a 8-million gallon holding pond. From this pond, water may be released by gravity flow to irrigate farms north of the plant or pumped by two 350-hp pumps to the North Field Ditch for delivery to other irrigated areas.

The original plan at the time the plant was designed was to pump the water from the 8 mg pond to a 150 mg holding reservoir from which gravity flow would provide water for sprinkler irrigation of the City cemetery, golf course, ball park, highway median, and high school and college lawns. However, because the effluent does not meet the State Standards of 10 mg/l biochemical oxygen demand (BOD), 5 mg/l suspended solids (SS), and three total coliform/100 ml, use of the effluent has been restricted to flood irrigation of approved types of agriculture and for watering the highway medians (Fred Pearson, personal communication).

Data were obtained from the Cedar City Wastewater Treatment Plant (WWTP) on flow, biochemical oxygen demand (BOD), suspended solids (SS), pH, total coliform, and fecal coliform, and these are shown in Table 26. Flow data were available for the period August 1979 to November 1979. Quality data were available for the period December 1976 to January 1980.

Flow data were collected at approximately 2-hour intervals from 6:00 to 16:00 on week days, and consequently the calculated average flows are probably higher than the true daily averages. However, the maximum and minimum values may be representative. The average effluent BOD of 220 mg/l is only slightly greater than a typical value of 200. Mr. Doug Craig of Engineering Science, Denver (personal communication) has been evaluating the plant as part of an EPA operation and maintenance state pass-through grant. Based on 102 samples collected in 1979 he calculated an average hydraulic loading (without circulation) of 158 gpd/ft^2 to the primary and 298 gpd/ft^2 to the secondary trickling filters. The current recycling is not gaged; however, it could result in hydraulic loadings 2 to 3 times those above or about 395 gpd/ft^2 and 745 gpd/ft^2 for the primary and secondary respectively. Typical hydraulic loading rates are between 200-900 gpd/day/ft^2. Mr. Craig calculated average hydraulic loading rates

Table 26. Summary of available data at the Cedar City Wastewater Treatment Plant (one standard deviation is shown with averages).

Parameter	Average	Maximum	Minimum	Number of Data Points	Comments
Average Influent Flow (gpm)	1262 ± 203	1736	895	40	Average over period 6:00 - 16:00
Minimum Instantaneous Flow (gpm)	431 ± 68	-	349	58	Minimum in period 6:00 - 16:00 (min. occurs at 6:00)
Maximum Instantaneous Flow (gpm)	1770 ± 330	2822	-	50	Maximum in period 6:00 - 16:00 (max. occurs between 10:00 and 14:00)
Influent BOD (mg/l)	220 ± 40	268	141	39	Grab samples
Effluent BOD (mg/l)	28 ± 20	70	8	39	Grab samples
Influent SS (mg/l)	172 ± 46	358	92	39	Grab samples
Effluent SS (mg/l)	10 ± 6	25	1	39	Grab samples
Influent pH	7.5 ± 0.4	8.3	6.8	39	Grab samples
Effluent pH	7.6 ± 0.3	8.3	7.0	39	Grab samples
Effluent Total Coliform (Log count/100 ml)	2.67 ± 0.62	3.86	1	37	Grab samples
Effluent Total Coliform (count100 ml)	468	7200	10	37	Grab samples, Geometric mean
Effluent Fecal Coliform (Log count/100 ml)	1.06 ± 0.81	2.92	0	37	Grab samples
Effluent Fecal Coliform (count100 ml)	11	835	1	37	Grab sample, Geometric mean

of 28 pounds BOD/day/1000 ft^2 and 9 pounds BOD/day/1000 ft^2 for the primary and secondary trickling filters respectively. Typical organic loading range between 10 and 60 pounds BOD/day/1000 ft^2.

Table 26 indicates high effluent BOD concentrations. Several factors may contribute to the high effluent BOD concentrations from a modern plant operating within practical theoretical ranges for hydraulic and organic loadings: 1) toxic or growth inhibiting materials in the influent and 2) suboptimal operating procedures.

Little effort has been made to control industrial waste discharges into the collector system. There are two apparent sources of organic loading. The Cedar Packing Company discharges process wastes to the sewer with an estimated daily flow of 4,100 gallons and 250 pounds of BOD (208 WQMP). The Coca-Cola Bottling Company discharges process wastes to the sewer with an estimated average daily flow of 11,000 gallons and a BOD of 2 pounds. A paint factory and numerous gas stations and mechanics shops may also discharge to the sewer systems. Vernile Terry (personal communication) reported a massive gas spillage entering the plant over a two day period in January 1979. The discharge damaged the biological growth and resulted in effluent BOD concentrations of over 70 mg/l. It took the plant several months to recover.

Trickling filters in Utah do not normally produce low soluble BOD in the effluents. However, it may be possible to improve the present quality of effluent at the Cedar City plant by altering operating procedures.

2. Maximum Capacity Without Changing the System.

The existing collection system is adequate for the present population. The two main sewers entering the wastewater treatment are operating at 60 to 70 percent of capacity. Extrapolating, the existing sewer mains would be adequate for a population of 19,000, but normal collector lines would be required for the areas of expansion.

The treatment plant was designed for 2.26 mgd (a population equivalent of 19,000). However, the data in Table 26 indicate that the effluent concentration already exceeds state standards much of the time. Unless the performance of the plant can be improved to reach design criteria, new facilities will need to be constructed for any increase in population. Plant performance may possibly be improved by restricting toxic chemicals from the sewer system, by requiring pretreatment of high organic industrial discharges to the sewer system, by trying alternate plant operating procedures, and by providing operator training.

The State of Utah specifies a maximum peak flow rate of 5 gpm/ft^2 when a proportionate number of filters are removed from operation for the periodic backwash cycle. Using these criteria, the filter system is inadequate to serve the present population.

3. Implications of Major Growth.

Normal expansion of the sewer collector system will be necessary to serve developing areas. If the existing plant performance can be improved to meet the design capacity of 19,000 population equivalents, then it is conceivable that the plant could serve the projected populations of Cedar City with MX in 1987 by operating at a 5 percent overload. Plant improvement could possibly be obtained by restricting the materials being discharged to the sewer system and by implementing operating modifications. Approximately 700 square feet of additional filter area would be required to comply with State specifications at a population equivalent of 19,900.

The historical data indicate that improvement of plant performance is unlikely and that additional treatment facilities will be required. The most likely methods would be an oxidation ditch or a stabilization lagoon followed by sand filtration.

IV. Hinckley, Deseret, and Oasis

1. General.

Kaiserman Associates (October 1979) conducted a Regional Utility Study to identify problems within the existing Hinckley, Deseret, and Oasis wastewater disposal systems and to propose recommendations to enable these communities to support various levels of projected growth. One growth scenario included population increases due to construction of the Intermountain Power Project (IPP), a 3,000 megawatt coal-fired electric power generating plant proposed for construction 10 miles north of Delta. Kaiserman (1979) estimated that IPP construction would cause a rapid increase in population reaching a peak in 1987 and then declining to a more stable base population, including IPP permanent support personnel, by about 1990. They also estimate that approximately 10 percent, 5 percent, and 3 percent of the total IPP construction and permanent support populations will reside in Hinckley, Deseret and Oasis respectively. The population projections for this three-community area are shown in Table 27. The population associated with MX is based or the assumption that 18 percent of the total MX population will reside in these three communities.

2. Existing Wastewater Collection and Treatment Systems.

The residents of Hinckley, Deseret, and Oasis presently use individual domestic septic tanks and drain fields for sewage disposal. The majority of these systems do not function properly due to low soil permeability and a high groundwater table. Soil permeabilities are classified as medium (0.6 to 2.0 inches per hour), medium low (0.2 to 0.6 inches per hour), and

Table 27. Projected populations for the Hinckley-Deseret-Oasis area.

Situations	1980	1987	1995
Growth without IPP and MX (Kaiserman)	925	1050	1160
Growth with IPP but without MX (Kaiserman)	925	1600	1410
Growth with IPP and MX	925	4000	2700

low (0.06 to 0.2 inches per hour). The Utah State Division of Health requires permeability rates exceeding 1.0 inch per hour for septic tank installations. The groundwater reservoir beneath these three communities is comprised of three zones; a shallow purched aquifer and two artesian aquifers.

As a result of the inadequate drainage, many residents of these three communities have abandoned their septic tanks and connected their wastewater lines to land drains which had been installed in past years to lower the groundwater table. The wastewater discharged into the land drains eventually surfaces in open ditches causing health hazards, unsightly algal growth, and offensive odors. When the land drains are blocked, the groundwater builds up and causes flooding in nearby basements.

3. Maximum Capacity Without Changing the Systems.

Kaiserman Associates (1979) concluded that the present wastewater disposal systems do not meet state and federal regulations. They recommend that each community install sewer collection systems and transport the wastewater to containment lagoons. In order to provide adequate treatment and to accommodate the expected permanent support personnel for the IPP project, they recommend an 11-acre lagoon to serve Hinckley and an 8-acre lagoon to serve Deseret and Oasis. Because of the existing groundwater conditions, Kaiserman Associates recommend that the sewer lines be placed above the existing land drains wherever possible in order to allow the land drains to work effectively in draining the groundwater. They also recommend that all existing wastewater connections be transferred to the new sewer lines. However, to hold the new system to a reasonable size, they emphasize that no roof drains or connections which would permit groundwater, surface water, or runoff to enter the sewer system should be allowed. After the new wastewater system is installed, the existing land drains should be cleaned.

There are some locations in the area that are acceptable for septic tanks and leach fields. Each propsective home location must be considered individually to determine whether or not it meets State design criteria.

4. Implications of Major Growth.

a. Projected Wastewater Loads: The communities in the study area do not have a way of monitoring wastewater. It is assumed (Kaiserman, 1979) that wastewater amounts are similar to those from other communities in the area or 70 gpcd plus infiltration of 30 gpcd or a total of 100 gpcd delivered to the treatment facility. Table 28 summarizes the design criteria proposed by Kaiserman (1979).

Table 28. Wastewater design criteria.

1) Evaporation equals 47 inches per year (80% during May-October period)
2) Precipitation equals 7.1 inches per year
3) Lagoon seepage loss equals 46 inches per year
4) Allowable organic loading for a primary pond equals 40 lbs BOD/acre/day
5) Total flow (including infiltration) = 100 gallons per capita per day
6) BOD load equals 0.17 pounds BOD per capita per day (i.e. 200 mg/1 at a flow of 100 gpcd)

Based on analysis of several wastewater treatment alternatives, Kaiserman Associates (1979) concluded that the only two feasible options were 1) complete containment lagoons or 2) stabilization ponds (120 days) with land application. Stabilization ponds with land application has several disadvantages. A winter storage reservoir would need to be constructed in order to hold water until the growing season and at least one lift pump would be required for irrigation delivery. In order to protect public health, land applications would only be allowed to land having a relatively low groundwater table in areas restricted from public access (1000 foot buffer zone). Overall, the area does not have good conditions for land application, and it was concluded that the complete containment lagoon would be the more cost effective treatment method.

Based on the population projections in Table 27 and the design criteria in Table 28, the area required for complete containment lagoons are shown in Table 29.

c. Conclusions: The wastewater treatment in Hinckley, Deseret, and Oasis is presently provided by individual septic tanks and leach

Table 29. Areas of complete containment lagoons for possible situations.

Situation	1987		1995	
	Flow (acre-ft/yr)	Area (acres)	Flow (acre-ft/yr)	Area (acres)
Growth without IPP and MX	116	16	128	18
Growth with IPP but without MX	176	24	155	22
Growth with IPP and MX	440	61	297	41

fields. Because of the generally low permeability of the soil and the high water table, existing conditions violate State and Federal standards and could cause health hazards. Land drains do not function properly because they are being used as wastewater lines and, consequently, shallow water tables rise causing further deterioration of the wastewater situation.

Sanitary sewer collection systems will need to be constructed for each of the communities. The sewer lines should be placed above the existing land drains wherever possible in order to allow the land drains to work effectively in draining the groundwater. Storm drains should be kept entirely separate from the sanitary sewer system.

The required containment lagoon area for the three communities would increase from about 19 acres to between 41 to 61 acres with the influx of MX personnel. This drastic increase in magnitude justifies reconsideration of the number and location of lagoons.

V. Garrison.

There is no public sewer system in Garrison. Residential wastewater disposal is by individual septic tanks and drainage fields. Oxidation ponds appear to be the most cost effective method of treating wastewater produced by major MX related growth in that area. The climate is similar to the Delta region and pond areas for any assumed population can be estimated by using the per person quantities given in Table 25.

SUMMARY

The impacts of the proposed MX missile complex upon the water supply and waste treatment systems of the Utah municipalities of Milford, Delta, Cedar City, and the smaller communities of Hinckley, Deseret, Oasis, and Garrison were analyzed. For purposes of estimating the impact of the MX complex, the total associated population increase within Utah was taken as 30,000 during a construction phase peaking in 1987 and then 15,800 on a permanent basis after construction is completed. The distribution of this population increase among the affected communities was taken as follows:

	MX Population Increase	
Community	Construction Peak	Permanent
Milford	12,500	6,600
Delta	10,250	5,410
Hinckley, Deseret, Oasis	2,250	1,190
Cedar City	5,000	2,600

These population increases were assumed as being additional to the number of people who would otherwise be living in each community. The impacts were estimated from a per capita basis so that the effects of other population totals or distributions could be easily estimated.

Hydrologic System

All of the communities examined currently obtain their entire water supply from groundwater. No surface water is currently being used because of the much less expensive, good quality groundwater which is usable without treatment. Nor is there any expectation of surface water being developed for municipal use through the next decade during which MX impact is scheduled to peak. Cedar City has plans underway to import and treat surface water in the more distant future. For this study, the evaluation of the hydrologic system focused entirely on groundwater.

All of the communities obtain their groundwater from wells pumping from unconsolidated sediments in the valley bottoms, and these aquifers seem to be the economically feasible source for MX related increases in municipal water production (usually with a corresponding decrease in irrigated agriculture). Cedar City also has substantial production from springs located on alluvial fans in two adjacent canyons.

In two of the three principal cities (Milford and Delta), groundwater of excellent quality is being produced from wells within the City boundary while nearby irrigation wells, north and south of both Cities, produce water of unacceptable salinity (also unacceptable arsenic levels south of Delta). In Milford, the poor quality water is generally from a shallow aquifer; and the deep aquifer (from which City wells produce) has kept its high quality due to artesian pressure which leaks fresh water upwards rather than allowing shallow contaminated water to enter the deep aquifer. However, aquifer outflow exceeding recharge (mining) has occurred in recent years, and further increases to supply MX-related demand could reverse the pressure gradient and contaminate the deep aquifer.

Delta is located over a relatively isolated (but limited) reservoir of fresh, low salinity water. Here also, groundwater is already being mined, and any major increase in pumping will eventually cause deterioration of the aquifer quality. Thus in both communities, water quality deterioration is the limiting factor to further groundwater development.

In Cedar City, the single municipal well within the City produces water unacceptable for culinary purposes and therefore is used for irrigation. The municipal system obtains its high quality supply from deep wells several miles north and south of the City.

In and around all of the communities studied except Garrison, the Utah State Division of Water Rights has closed the basins to further groundwater (and surface water) appropriations. Therefore, any additional municipal groundwater withdrawls will have to come from either 1) existing rights held by the communities above their present production rates or 2) water rights purchased from farmers (which imply a decrease in irrigated agriculture) and converted from agricultural to municipal uses. The conversion will probably require a change in point of diversion with its associated facility costs. Any conversion requires approval by the State Engineer. Considerations related to such approvals include local drawdown increases (interference with other wells) and possible water quality deterioration due to pressure gradient changes. In some cases approval may be obtained when others are adversely affected provided that they receive acceptable compensation for their increased pumping lifts.

Water Supply Systems

1. Milford: Milford City, with a present population of 1500, has an adequate system except for insufficient storage capacity and considerable water loss through leaking mains. The peak day demand, however, is already close to pumping capacity. Without MX, the 1987 demand will require one more well (for which they already have the necessary water right), an additional 0.25-mg reservoir (or preferably replacement of existing deteriorated reservoirs with a larger one), and some modest improvement and expansion of the distribution system.

With projected MX growth, however, the population would increase from 1500 to 14,500 in seven years. Every component of the existing system would be totally inadequate and an essentially new water system would be required to serve the largely new City. The amount of expansion is perhaps best illustrated by the required increase in peak day pumping capacity from the current 1.63 to 10.7 mgd. This would require a network of new wells (six additional 1,000 gpm wells for example) and the purchase of additional water rights from farmers which would remove the equivalent of about 600 fully irrigated acres from production. Despite this major increase in municipal pumping, agriculture so dominates the existing pumped groundwater volume in the valley (98 percent compared to 2 percent for municipal) that the overall hydrologic system will scarcely be impacted Great care will be necessary, however, to avoid local well interference and water quality deterioration through proper siting and sizing of the new wells.

2. Delta: Delta City has a water system which is completely adequate for the present 2100 population except for a shortage of reservoir storage. It would even be adequate for the projected 1987 population of 5300 (assuming IPP is constructed but MX is not) except for a needed additional increase in storage and expansion of the distribution system to serve new users. As in the case with Milford, however, the additional population growth associated with MX construction (an increase from 2100 to 15,550 in seven years) would make all water system facilities completely inadequate. The peak day pumping capacity would be required to increase from 2.73 mg (1.15 actual peak day use) to 8.5 mg. A new well field would be required to produce about 5000 additional gpm during peak periods. This may be

possible but would likely be difficult on a long term basis because of the relatively close proximity of brackish water to the north and high arsenic level water to the south. The facts that 1) this high pumping rate would be required only during peak summer months (average rate is only 43 percent of peak day) and 2) the population should decrease substantially during the following five years, due to completion of construction of both IPP and MX, suggests that the aquifer capacity and quality problems could be solved if the new well field is designed properly. The new well field would require the removal of 428 acres from irrigated agriculture in addition to the major reduction already caused by IPP (which has also increased water right prices in the area many fold).

3. Cedar City: The existing water system is adequate for present demand volume but is borderline in terms of peak day pumping capacity. The City has adopted a policy of purchasing all nearby surface or groundwater rights which become available and this has given them existing groundwater rights which with only a minor increase will be adequate for peak period 1987 demand including projected MX growth. The present total peak period pumping plus spring flow capacity is about 32 percent short of meeting 1987 demand with MX, but the City has already embarked upon a major expansion project which will produce a more than adequate water supply and distribution capacity for MX related growth. The existing 13,000 population of Cedar City would be increased by only about 50 percent in 1987. This contrasts with much greater population growth in the Milford and Delta areas and the relative impact upon Cedar City would therefore be much less.

4. Hinckley/Deseret/Oasis: These three communities south and west of Delta are served by a public water system in Hinckley and private wells in Deseret and Oasis. The current tri-city population is 925 and is projected to increase to 4,000 due to combined IPP and MX construction. The existing water source for Hinckley produces water with unacceptable arsenic levels. Naturally occurring arsenic levels exist in the deep aquifer in much of this region. The three communities are presently attempting to develop a regional water system with a well located 3 to 4 miles northwest and outside the area with the arsenic problem. The current plans for this system are to serve the IPP projected impact, but not MX. The planned capacities would have to be increased almost three fold to also handle MX demand. This would be difficult hydrologically in view of simultaneous huge growth in Delta City. The only way to successfully design new well fields for both Delta and Hinckley/Deseret/Oasis would be to combine all these systems into a single coordinated regional project. Even then, the ability to avoid serious well interference and deterioration of the deep regional aquifer is in doubt.

5. Garrison: The small community of Garrison (population 60) has no existing public water system (private wells are used). Any MX related growth in this area would not have the advantage of an existing municipal infrastructure; rather a new city would have to be created. Growth in this area would have the advantage, however, of access to the most favorable water resource situation in the entire study area. Snake Valley has substantial amounts of good quality unappropriated groundwater. Growth in this area would not require a reduction in irrigated agriculture.

Wastewater Systems

Wastewater collection and treatment to serve an increased population does not present so difficult a problem in any of the communities examined as does water supply; that is, the basic constraint of water resource availability is not the relevant issue. The need is to obtain the necessary financial resources with sufficient lead time to construct the collection and treatment facilities. With the possible exception of Cedar City, which already has a tertiary treatment plant, the economically viable treatment approach for the communities is to construct oxidation lagoons. The availability of large areas of relatively inexpensive land near each community motivates this approach.

Both Milford and Delta already have oxidation lagoons, but as with the water supply system, the MX related growth will require much greater capacities. The Cedar City treatment plant is already overloaded. A question exists concerning type of expansion to Cedar City's treatment facility. If the effluent quality can be improved sufficiently (by adding additional capacity) to allow recycling by sprinkling public areas such as the college and golf course, this would have the advantage of reducing demand upon the culinary supply system. If not (and previous results are not encouraging), then the more cost effective expansion investment may be to add an oxidation lagoon.

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APPENDIX A

EFFLUENT AND RECEIVING STREAM STANDARDS

Summary of Discharge Standards

Discharge To	Level of Treatment
Surface Water	Meet polished secondary treatment and maintain Class "C" standards in receiving stream.
Irrigation--confined	Class "D" water standards
Irrigation--unconfined	Polished secondary treatment

The water quality requirements for Class "C" and "D" waters are shown on the following pages.

Utah Effluent Standards

Parameter	Secondary Treatment	Polished Secondary Treatment
BOD		
(30 day arithmetic mean)	25 mg/1	15 mg/1
Maximum % of influent	15%	10%
Suspended Solids		
(30 day arithmetic mean)	25 mg/1	10 mg/1
Maximum % of influent	15%	10%
Total Coliform (30 day arithmetic mean)	2000/100 ml MPN	200/100 ml MPN
Fecal Coliform (30 day arithmetic mean)	200/100 ml MPN	20/100 ml MPN
pH Units (range)	6.5 - 9.0	6.5 - 9.0

Summary of Class "C" Water Quality

Requirements, August 1971

It should be unlawful to discharge wastes resulting in:

- Objectionable deposits
- Floating debris, oil, scum and other matters
- Objectionable color, odor, taste, turbidity
- Interference with Class "C" water uses

The following standards shall not be violated:

	Limits			Limits			Limits	
	Recommended	Mandatory		Recommended	Mandatory		Recommended	Mandatory
Item	Mg/l	Mg/l	Item	Mg/l	Mg/l	Item	Mg/l	Mg/l
TDS	500		Cu	1.0	--	NO_3	45	--
As	0.01		CN	0.01	0.02	Pheno	1.001	--
Ba	--		F	1.0	2.0*	Se	--	0.01
CCE	0.2		Fe	0.3	--	Ag	--	0.05
Cd	--		Pb	--	0.05	SO_4	250	--
Cl	250		Mn	0.05	--	MBAS	0.5	--
Cr	--					An	5.0	--

MPN Coliforms 5000/100 upper limit (average)
BOD 5 mg/l upper limit
DO 5.5 mg/l lower limit
Radionuclides not to exceed 1/30 of the MPC** values as defined in National Bureau of Standards Handbook 69

*Dependent on Climate
**Maximum permissible concentration in water

Uses of Class "C" Water:

Municipal (following complete treatment)	
Aesthetics	Wildlife
Irrigation	Recreation (except swimming)
Stock Watering	Industrial Supplies
Fish Propagation	Other as determined by Board and Committee

NOTE: A user of surface water diverted from water of the State will not be required to remove any pollutants which he has not added before returning the diverted flow to the original water course.

Summary of Class "D" Water Quality
Requirements, August 1971

It should be unlawful to discharge wastes resulting in:

- Slicks
- Floating solids
- Suspended solids
- Toxic materials
- Interference with Class "D" waters

The following standards shall not be violated:

	Limits			Limits			Limits	
	Recommended	Mandatory		Recommended	Mandatory		Recommended	Mandatory
Item	Mg/l	Mg/l	Item	Mg/l	Mg/l	Item	Mg/l	Mg/l
TDS	500		Cu	1.0	--	NO_3	45	--
As	0.01		CN	0.01	0.02	Pheno	1.001	--
Ba	--		F	1.0	2.0*	Se	--	0.01
CCE	0.2		Fe	0.3	--	Ag	--	0.05
Cd	--		Pb	--	0.05	SO_4	250	--
Cl	250		Mn	0.05	--	MBAS	0.05	--
Cr	--					An	5.0	--

MPN Coliforms 5000/100 upper limit (average)
BOD 25 mg/l upper limit
Radionuclides not to exceed 1/30 of the MPC** values as defined in National Bureau of Standards Handbook

*Dependent on Climate
**Maximum permissible concentration in water

Uses of Class "D" Water:

Accepted	Unaccepted
Limited irrigation, industrial uses	Irrigation of pastures
Other as determined by Board and Committee	Irrigation of recreation areas
	Irrigation of root crops of any low growing crops produced for consumption.

NOTE: A user of surface water diverted from water of the State will not be required to remove any pollutants which he has not added before returning the diverted flow to the original water course.

Land Application

A sewage effluent may be discharged through land application by the following methods:

Irrigation of confined areas having controlled access:

Sewage effluent used for irrigation on areas which are fenced and have controlled access must meet secondary or Class "D" effluent quality.

Irrigation of unconfined, isolated areas:

For irrigation of unconfined areas secondary treatment would be required.