Cold Springs Wastewater Facility Plan

Prepared For Washoe County Department of Water Resources

Kennedy/Jenks Consultants

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Cold Springs Wastewater Facility Plan
Executive Summary

Introduction

The Cold Springs Valley hydrographic basin in Washoe County, NV, is home to 3,800 people, and the population is expected to double in the next seven years. Continued residential development and expansion of the Bordertown Casino has necessitated wastewater facility planning to make sure future wastewater flows are properly treated and managed as part of the water resources of the valley. Figure 1 shows the facility planning area.

Groundwater monitoring has shown elevated concentrations of nitrate in the areas where septic tanks installed before 1997 are used for wastewater disposal. Figure 2 shows the nitrate plume. Protection of groundwater quality must also be addressed in wastewater planning

The existing wastewater treatment plant serves sewered homes built after 1997. It is expected that the plant will be at capacity by the year 2006. This facility plan addresses the required treatment plant expansion and the wastewater collection and/or septic conversion alternatives for the existing homes using septic tanks.

Background

Cold Springs Valley is a 29 square mile basin located approximately 15 miles north of Reno, Nevada along US-395. The Cold Springs Valley is a closed basin. Water is introduced into the Cold Springs Valley only through rainfall, snowmelt and surface runoff from the surrounding mountains. Groundwater is sustained by that precipitation with possibly some minor groundwater migration from Long Valley. All municipal and industrial water is provided by wells in this basin. Wastewater treated at the existing Cold Springs Wastewater Treatment Plant is discharged back into the groundwater system through infiltration.

During years of above average precipitation, groundwater rises above the lakebed of White Lake. Annually, several seasonal creeks from the adjacent mountains flow into White Lake. The shallow lake is subject to significant evaporation during the summer months. This evaporation, and water lost to domestic consumption, is the only significant outflow from the Cold Springs basin.

A groundwater flow and solute transport model was developed by Broadbent & Associates as a tool to help evaluate various wastewater planning alternatives for Cold Springs.

In the Cold Springs Valley within the facility plan limits there are four existing wastewater systems:

- Standard septic systems with leach field disposal, serving about 1000 homes.
- Denitrifying septic systems with leach field disposal, serving fewer than 20 homes.
- Standard septic systems with leach fields and dry sewers in the street, serving fewer than 160 homes
- A community sewer system with the Cold Springs Wastewater Treatment Plant, serving about 600 homes. Effluent is land applied in rapid infiltration basins (RIB).

The large number of septic tanks at a relatively high density is the primary cause of an increase in nitrate concentrations in the near surface groundwater. Groundwater sampling by Washoe County identified the development of a plume of nitrate contamination that now exceeds the allowable standard of 10 mg/l nitrate-nitrogen.

The existing wastewater treatment plant was designed to treat an average daily flow of 0.35 MGD. It is expected that the plant will be at design flow by the year 2006.

Treatment Plant Expansion

The community wastewater system includes the Cold Springs Wastewater Treatment Plant (CSWWTP), which was constructed in 1997 to allow for further development of the Cold Springs Valley. There are currently about 600 sewer service accounts for the community wastewater system. As of July 2002 the average daily influent to the treatment plant is approximately 60,000 gallons. The CSWWTP includes a sludge grinder, two activated sludge sequencing batch reactors (SBRs), an aerobic digester, two lined sludge storage lagoons, and six rapid infiltration basins.

The proposed expansion of the Cold Springs Wastewater Treatment Facility was based on an average flow in the maximum month of 325 gallons/day/equivalent residential unit (ERU). The projected flow including existing and planned new development is 0.9 MGD. If all homes on septic tanks were also connected to the sewer system the future flow would be 1.33 MGD.

Kennedy/Jenks Consultants performed a detailed study of the existing wastewater treatment plant and several expansion alternatives. Each of the proposed processes was evaluated for feasibility and compatibility with the existing treatment plant. Evaluation categories including capital and O&M costs, effluent and sludge quality, expandability and flexibility, treatment efficiency, land requirement, aesthetics, and odor concerns, were then used in ranking the unit process alternatives.

After an evaluation of each process alternative, the following were chosen for expansion and upgrade of the CSWWTP.

- Influent Lift Station
- Screening – Perforated Basket
- Grit Removal – Vortex
- Secondary Treatment – Additional SBRs
- Disinfection – Chorine for reused effluent and UV if future regulatory requirements are put in place for land applied effluent
- Filtration
- Sludge Stabilization – Aerobic Digestion
- Sludge Dewatering – Centrifuge
- Effluent Recycling – additional RIBs, with some reuse at Lifestyle Homes

A total project cost of $6,879,800 was determined to upgrade the CSWWTP for a 0.45 MGD capacity increase. This cost includes construction, design, construction management and permitting.

An environmental review of the proposed expansion to the CSWWTP was performed. The expansion project was concluded to have no significant impact to the environment.

Sewage Collection/Conversion Alternatives

Part two of the Cold Springs Wastewater Facility Plan addresses alternatives developed for the existing septic systems within the facility plan limits to account for the problem of groundwater pollution. Also, sewage collection systems for the existing Nancy Gomes Elementary School, the existing areas with dry sewers, and Bordertown development and expansion are investigated.

Six alternatives for sewage collection/septic conversion for the Cold Springs Valley were developed.

1. Converting all the existing septic systems to de-nitrifying septic systems.
2. Connecting all the existing lots with septic tanks to a vacuum collection system for treatment and disposal to an expanded CSWWTP.
3. Connecting all the existing lots with septic tanks to a grinder pump collection system for treatment and disposal to an expanded CSWWTP.
4. Connecting all the existing lots with septic tanks to a gravity fed/two-lift station collection system for treatment and disposal to an expanded CSWWTP.
5. Connecting all the existing lots with septic tanks for a gravity fed/four-lift station collection system for treatment and disposal to an expanded CSWWTP.
6. Connecting the dry sewered area #2, the Nancy Gomes Elementary School and the residences with gravity access to the existing Whippoorwill/Puffin sewer main with associated collection system improvements for treatment and disposal to an expanded CSWWTP.

These alternatives were evaluated according to: groundwater contamination reduction potential, cost, reliability, and impact to residents.

The recommendation is Alternative No. 6, connecting the Nancy Gomes Elementary School, dry sewer area #2, and the residential lots with gravity access to the Whippoorwill/Puffin sewer line and then to the community sewer. This alternative has the lowest cost at $1,684,000. The hydrogeological analysis indicates by implementing this alternative a steady decrease in nitrate concentration will be realized. According to the groundwater model, this action would result in nitrate concentration levels below 10 mg/l after about 35 years. The decrease is partly the result of reducing pollutant. However the primary cause for groundwater quality improvement will result from future development by Lifestyle Homes. The additional flows treated at the CSWWTP with effluent disposed in RIBs will result in dilution of the near surface groundwater.

It is also recommended that the conversion is considered to be a first phase. Groundwater monitoring should be continued to track water quality improvement. If phase one is not effective, then Alternative No. 2 is recommended as the ultimate solution. Connecting all existing septic lots to a vacuum collection system has a total cost of $8,480,000 and can be built in two or three phases.

Bordertown Improvements

Bordertown is considering an expansion of their existing developments. These developments would result in approximately a 100,000 gallon per day flow to the CSWWTP. A report by Gunderson Associates, LTD, stated that the Bordertown flow would use the Diamond Peak Lift Station to transfer waste to the CSWWTP. Given the Diamond Peak Lift Station flow and storage requirements, this station would be deficient to handle additional flow from Bordertown. A new private lift station would be constructed to convey Bordertown flows to the existing collection system and a new lift station by Washoe County would convey the flow to the CSWWTP.

Compliance with the Washoe County Comprehensive Regional Water Management Plan

The Cold Springs Wastewater Facility Plan followed the Chapter 6 Performance Goals of the Washoe County Comprehensive Regional Water Management Plan. Project Conformance Standards Nos. 27 and 28 are given as:

1. Projects which are subject to the review of the Water Planning Commission for conformance to the Regional Water Plan shall include the following:
    a. Projects defined as having regional significance.
    b. Projects that have regional effects on water, wastewater, or flood control.
2. In order to establish conformance with the Regional Water Plan, the project must satisfy the following:
    a. It must meet all pertinent standards as detailed in the Regional Water Plan.
    b. The project must be shown to be best based on all the criteria, compared with other alternatives analyzed.
    c. An evaluation must be provided of the project's impacts on other water-related disciplines.

Performance Goal No. 2, coordination among entities and disciplines, was followed. The planning was conducted with public participation at monthly meetings of the Cold Springs Citizen Advisory Board and a Citizens Wastewater Committee. Agencies that were consulted and included in the planning were Washoe County Utilities Division, District Health Department and Nevada Division of Environmental Protection. Performance Goal No. 3, conformance to the timing and sizing of facilities, was observed. This standard recommends that facilities be built with sufficient lead time to ensure public demands are met. Sizing of facilities shall be based on existing data and forecasts of future trends, including conservation, rather than on standardized, one-rule-fits-all assumptions. The CSWWTP expansion is based on actual population projections and future development trends of concrete data.

Performance Goal No. 7, maintaining a balance of water resources, was followed when creating the Cold Springs Facility Plan. A policy of protecting the groundwater quality, recycling wastewater, and recharging groundwater, and the long-term impact on the availability of water resources to meet all competing needs was examined.

Performance Goal No. 13, water quality standards, was followed, as well as No. 14, wastewater treatment and disposal guidelines. A driving force behind the facility plan was to improve the groundwater quality. The water plan also sites in Performance Goal No. 16 that when adverse surface or groundwater impacts occur as a result of a concentration of septic systems;

alternative sewage disposal, groundwater treatment, or other techniques shall be implemented. This is demonstrated in the wastewater collection/septic conversion alternatives analysis and the recommended outcome. Also, corrective action taken for remediation of groundwater contamination shall consider the level of cleanup desired by the affected community, realizing that public health concerns are typically the driving force for groundwater remediation, according to Performance Goal No. 20. This was followed in the facility plan and demonstrated in the phasing suggested in the addendum.

Finally, fiscal and economic standards are listed in Performance Goal No. 24 of the Water Plan. Non-economic criteria including, but not limited to, environmental impact, public impact, and archeological impact shall be evaluated during the program or project alternative selection process. An environmental review which included these and many other non-economic criteria was performed on the expanded CSWWTP. The Water Plan also recommends in Performance Goal No. 25 that hookup fees and user charges should be consistent with the costs of providing service. Economic decision making shall be based upon minimizing the costs to the entire community for providing adequate services. This was of utmost importance when developing the facility plan.

Conclusions and Recommendations

The expansion of the Cold Springs Wastewater Treatment Facility to 0.8 MGD to meet the demands of growth should be completed on the existing plant site using an expansion of the existing treatment process of activated sludge using sequencing batch reactors. This technology is proven to be capable of treating the wastewater to the discharge standard and is familiar to the wastewater treatment operators. This expansion will minimize the impacts to the community as well as the treatment plant staff and allow the facility to meet the demands of a growing community.

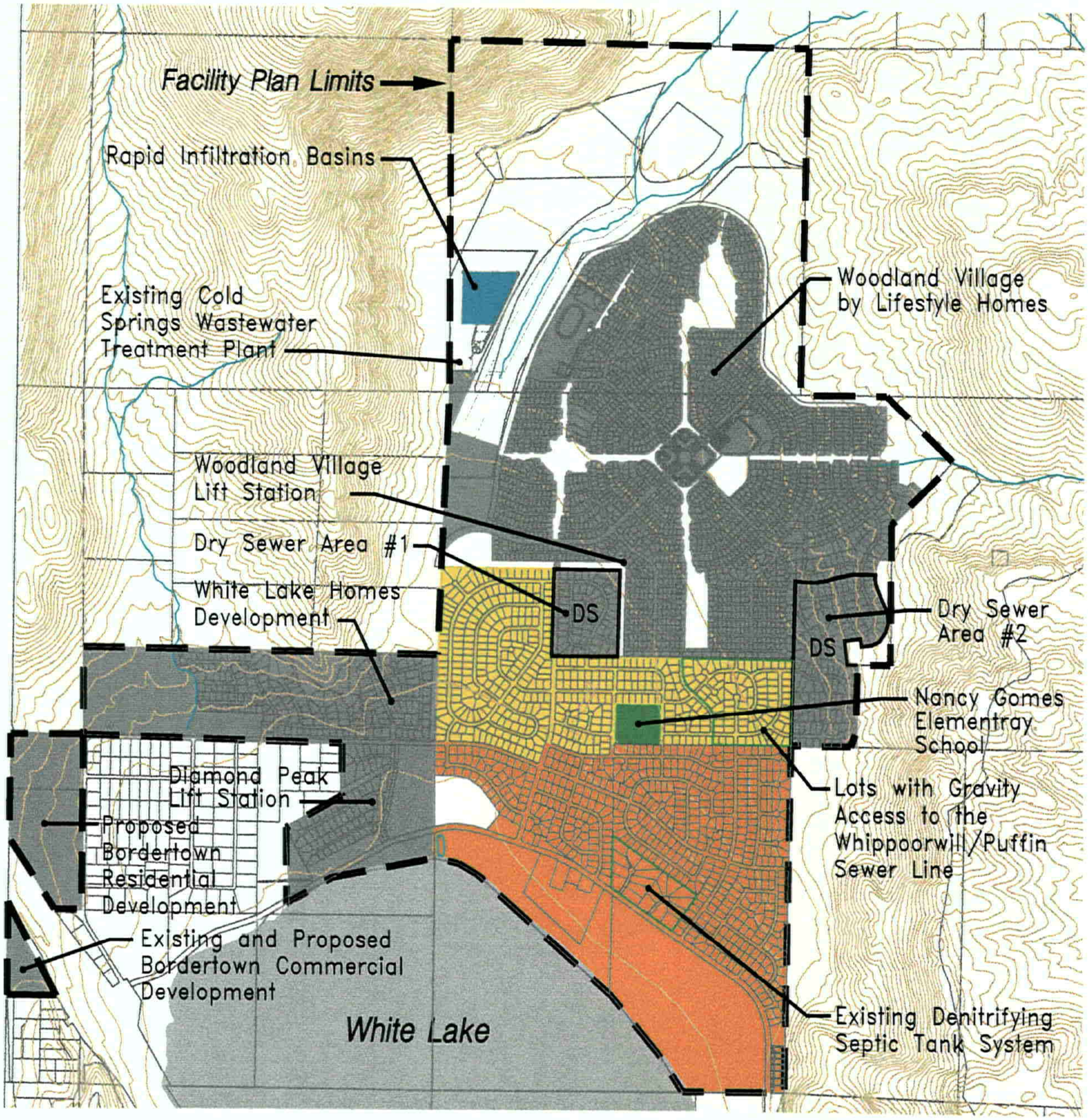
It is recommended that the wastewater collection/septic conversion alternative of converting the Nancy Gomes Elementary School, dry sewer area #2, and the residential lots with gravity access to the Whippoorwill/Puffin sewer line to the community wastewater system be pursued.

Phase One improvements are divided into the following three sub-phases.

- Phase 1A – Convert the Nancy Gomes Elementary School to the community wastewater system.
- Phase 1B – Convert all the residences in dry sewer area #2 to the community wastewater system.
- Phase 1C – Convert the residential lots with gravity access to the Whippoorwill/Puffin sewer line to the community wastewater system.

If, after implementation of all three sub-phases, the groundwater quality improvement is not realized, then the second phase can be implemented for the conversion of all septic systems with in the facility plan limits to the community wastewater system.

If Phase Two is to be implemented, it is recommended that the wastewater collection/septic conversion alternative using a vacuum collection system be the alternative implemented. This alternative provides the lowest cost of converting the existing septic systems, along with a number of other favorable attributes. The vacuum system also lends itself to a phased implementation so infrastructure improvements can be made as funding becomes available.



Legend

- Existing Septic System Southern Portions
- Existing Septic System Northern Portions
- Existing and Future Sewered Lots
- Rapid Infiltration Basins
- Existing Dry Sewers

N

Not to Scale

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Executive Summary

Facility Plan Map

K/J 007018.01
July 2002

Figure 1

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Monitoring Well Information - 2001

Well No.	Name	Well Depth (feet)	Perforations (feet below ground surface)	Nitrate-N (mg/L)
3	CC2	223	185-210	5.8
4	CC1	90	59-84	9.6
18	CSV2	45	40-45	32.0
19	CSV1	50	45-50	9.1
29	CSV6	15	5-10	15.0
30	CSV4	40	30-36	19.0
65	CC3	223	185-210	5.7

Legend

- Well Location
- 9-12
- 12-15
- 15-18
- 18-21
- 21-24
- 24-27
- 27-30
- >30

Notes

1). Concentration contours provided by Washoe County

2). Concentrations of Nitrate-N are in mg/L

N

Not to Scale

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Ground Water Nitrogen-N Plume Map
Concentration Contours 2001

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Figure 2

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Section 1: Needs Statement for Wastewater Facility Planning

1.1 Project Description

The population of the Cold Springs basin in Washoe County, NV, is expected to double to 6,200 in the next 7 years and reach a maximum in 2030 of 11,500, which is 3.7 times the current population (RTC Planning Dept.). The existing wastewater treatment plant was designed to treat an average daily flow of 0.35 million gallons per day (MGD) to serve the existing sewered homes and the active development in the Cold Springs basin. It is expected that the plant will be at design flow by the year 2006. Continued residential and commercial development in the Cold Springs Valley by Lifestyle Homes, Inc. and Woodland Village Homes, Inc (formerly Cold Springs 2000, Inc.) also referred to as "Lifestyle/Woodland" and others along with new school construction has necessitated wastewater facility planning to make sure future wastewater flows are properly treated and reintroduced into the environment. Average daily flow from the existing sewered homes and planned development is expected to be 0.87 MGD at build-out. In addition, the planned commercial expansion of the Bordertown Casino will result in an additional 0.043 MGD of wastewater with an organic load of approximately 150 lbs/day BOD (Gunderson Associates, 1999). Additionally a planned residential development by Bordertown will result in an additional flow of 0.056 MGD.

1.2 Facility Plan Parts

Washoe County is actively studying the impact of the existing 1,200 septic tanks in the Cold Springs basin on groundwater quality. The effect of these septic tanks was considered in the groundwater analysis of treatment plant expansion. Part One of this facility plan pertains to expansion of the existing wastewater treatment plant. Treatment plant expansion is required for future growth and the potential conversion of existing septic systems in the valley to the community wastewater system. Part Two of this facility plan develops and evaluates alternatives for the conversion of the existing septic systems.

Section 2: Planning and Service Area

2.1 Planning Area

The planning area for the wastewater treatment plant expansion encompasses the majority of the developed area in the Cold Springs basin. Refer to Figure 1 for the limits of the study area. Approximately 300 homes in the basin are not included in the wastewater facility study. The homes on 1-acre parcels near the northwest corner of White Lake were excluded from the wastewater study by the Washoe County Utility Division because of a lack of public support for the study in this neighborhood.

2.1.1 Location and General Information

Cold Springs Valley is a 29 square mile basin located approximately 15 miles north of Reno, Nevada along US-395. The developed residential area is in the southwest portion of the basin, roughly located in T21N, R18E, Sec 9, 16, 20 & 21, MDB&M. Cold Springs is a small residential community that generally began developing in the basin in the early 1970's. Currently there are approximately 1,800 single-family homes, a few commercial enterprises and the Bordertown Restaurant-Casino. The only industry in the basin is a manufacturer of wooden roof trusses located on the north shore of White Lake. Cold Springs is in an unincorporated portion of Washoe County, Nevada and is governed by Washoe County.

2.1.2 Topography

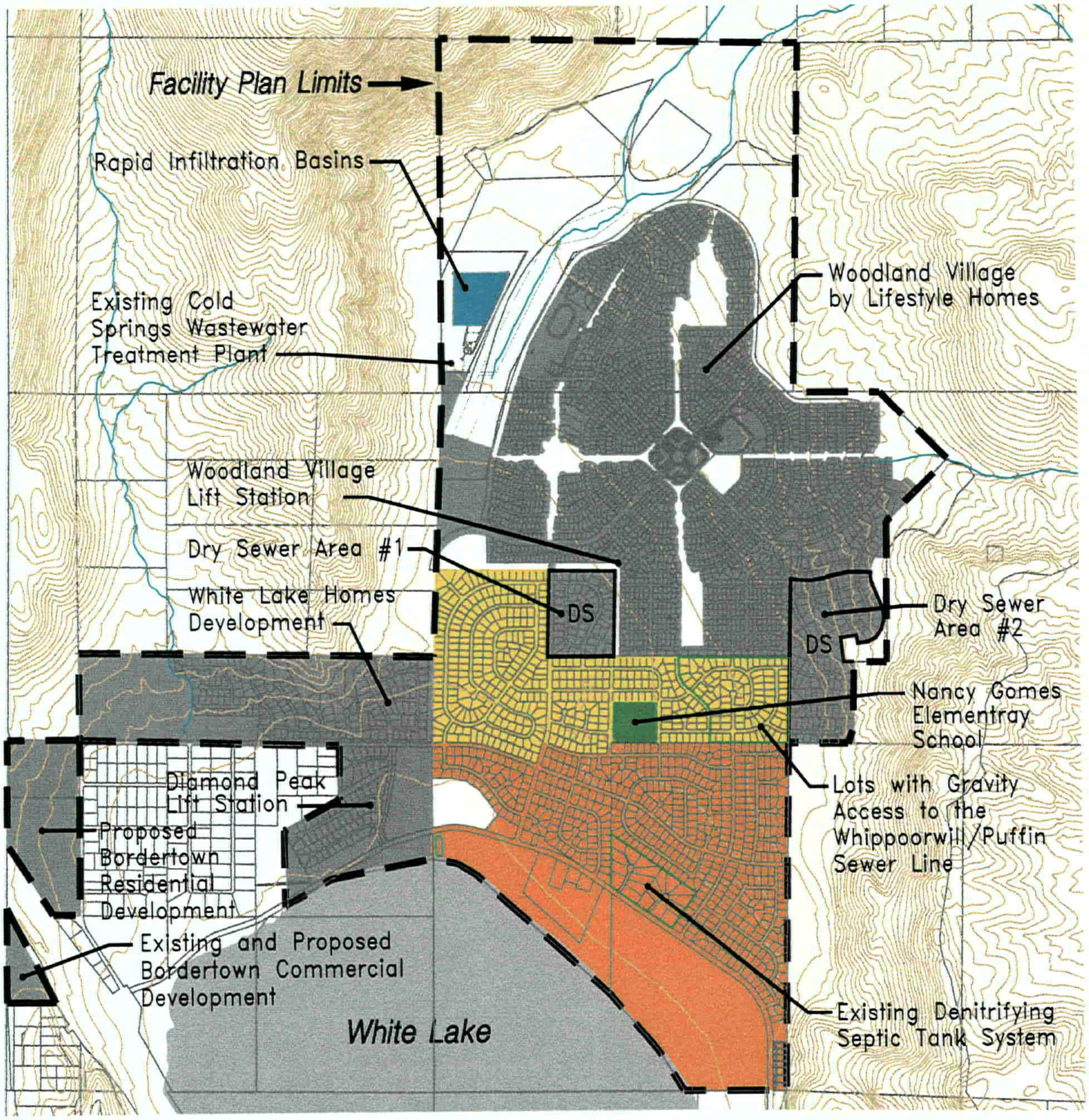
Cold Springs Valley is approximately 10 miles long and 2 to 3 miles wide, generally oriented north-south. It is bordered by Peavine Mountain to the southwest, the Granite Hills to the east and the Petersen Mountains to the northeast. The Peavine Mountain summit is at an elevation of 8,266 feet. The Petersen Mountains are at approximately 7,100 feet, while the Granite Hills are just under 6,000 feet. US 395 runs northwest-southeast across the southern portion of the valley. White Lake, an ephemeral, terminal lake, is located northeast of US 395, and is a typical basin playa. The playa has a surface area of approximately 1.5 square miles and is at elevation 5,035 feet.

2.1.3 Climate

Cold Springs Valley is located along the east slope of the Sierra Nevada Mountains, on the western edge of the Great Basin Desert. The area receives approximately 11.2 inches of precipitation per year (Nimbus, 1999). Temperatures range from an average daily high of 42° F in January to an average daily high of 85° F in July. Daily low temperatures average 18° F in January and 52° F in July.

2.1.4 Hydrology and Geology

Water is introduced into the Cold Springs Valley through rainfall and surface runoff from the surrounding mountains. Groundwater is sustained as a result of precipitation within the hydrologic basin with possibly some minor groundwater migration from Long Valley at the northeast. In a 1975 study, the USGS estimated annual groundwater recharge to be 500 acre-



Legend

- *Existing Septic System Southern Portions*
- *Existing Septic System Northern Portions*
- *Existing and Future Sewered Lots*
- *Rapid Infiltration Basins*
- *Existing Dry Sewers*

N

Not to Scale

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Facility Plan Map

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Figure 1

P:\007018.01\Facility-Plan-Addendum\Figure-1.dwg feet. In 1999, Nimbus Engineers calculated the total annual recharge to be 464 acre-feet. The septic tank/leach field systems for the homes located along the north side of White Lake contribute approximately 430 acre-feet of water annually to the shallow aquifer (Nimbus Engineers, 1999).

The Cold Springs Valley is a closed basin, with no surface water inflow or outflow. In a 1999 study of Cold Springs Valley groundwater by Nimbus Engineers it was indicated that minimal groundwater flows to Lemmon Valley, to the southeast, through fissures in the bedrock. The existence of this flow is based solely on studies of the geology of the area and no measurements have been made. During years of above average precipitation, groundwater rises above the lakebed of White Lake. Annually, several seasonal creeks from the adjacent mountains flow into White Lake. The shallow lake is subject to significant evaporation during the summer months. This, and water lost to domestic consumption, is the only significant outflow from the Cold Springs basin.

Basin geology is inconclusive, but it is believed that the groundwater in the basin is contained in two aquifers. The upper aquifer extends about 30 feet below ground level and receives the effluent from both the existing Cold Springs treatment plant and the existing septic tank systems. The lower aquifer, at approximately 200 feet below the ground surface, is the source of drinking water for the community for those residents on the community water system. Areas of impervious clay would prevent or hinder percolation from the upper aquifer to the lower aquifer. According to USGS hydrologist (emeritus) Steve VanDenburgh, the geologic record of the basin indicates that at several times in the past the majority of the basin was a lake. This would allow for settling of fine particles and the creation of a clay layer necessary to isolate the two aquifers. The extent of the clay layer(s) has not been fully investigated.

2.1.5 Demographics and Population

Currently there are approximately 1,800 single-family residences in the Cold Springs basin, with an estimated population of 3,800. The population generally consists of low and fixed income families. The majority of the residential neighborhoods are located on the north side of White Lake. A small number of homes are located southwest of US 395. There are no residences east or south of White lake.

2.2 Existing Wastewater Infrastructure

In the Cold Springs Valley facility plan limits there are the following three existing wastewater systems.

- Standard septic systems with leach field effluent disposal.
- Denitrifying septic systems with leach field effluent disposal.
- A community wastewater system including a collection system with the Cold Springs Wastewater Treatment Plant serving as the treatment facility. Effluent is land applied in rapid infiltration basins.

2.2.1 Standard Septic Systems

Approximately 1000 use individual septic tanks with leach fields for effluent disposal with the remainder of the homes connected to the community sewer. These homes using septic systems are located in the older portion of the community, close to the north shore of White Lake. The septic tanks are typically 1,000 to 1,250 gallons. The newest standard septic tanks in the basin were installed in 1995; most were installed between 1973 and 1995. It should be noted that there are a few septic systems that pre-date 1973. The maintenance of the septic tanks is the responsibility of the homeowner. Each time a tank is pumped, a ticket is prepared by the septage hauler and signed by the septage receiver. A copy of this ticket is sent to the Washoe County District Health Department.

Other areas utilizing standard septic systems have sewer lines installed in the streets but not in use (dry sewers). Fewer than 160 parcels were developed with dry sewers in the years 1991 to 1995 and are shown on Figure 1.

The Bordertown facility has two separate wastewater treatment facilities. The restaurant, casino and gas station are served by two septic tanks with a wet well which is pumped to four disposal fields. A 3,000-gallon gray-water tank with a deep disposal trench and a 2,000-gallon black-water holding tank serve a campground restroom and laundry. The campground also has a 5,000-gallon holding tank for the RV dump station. The holding tanks are pumped as necessary and the waste is disposed of at the Truckee Meadows Water Reclamation Facility (TMWRF).

2.2.2 Denitrifying Septic Systems

There are less than 20 denitrifying septic systems in the Cold Springs Valley that all dispose effluent via leach fields. Installation of these systems began in 1996. The systems were permitted by the Washoe County District Health Department. Operation and maintenance problems caused the Health Department to abandon any program to permit and monitor denitrifying septic tanks. Currently Washoe County does not have any operations or maintenance ordinance for denitrifying septic tanks and views them as standard septic tanks.

2.2.3 Community Wastewater System

2.2.3.1 Cold Springs Wastewater Treatment Plant

The community wastewater system includes the Cold Springs Wastewater Treatment Plant (CSWWTP), which was constructed in 1997 to allow for further development of the Cold Springs Valley. The CSWWTP is owned by Washoe County and is currently operated under contract by SPB Utility Services, Inc. for the Washoe County Department of Water Resources, Utility Division. The majority of residences constructed since 1997 utilize the community wastewater system. As of July 2002 there are approximately 600 sewer service accounts for the community wastewater system; the average daily influent to the treatment plant for the month of June 2002 was approximately 65,000 gallons.

The CSWWTP includes a grinder, two activated sludge sequencing batch reactors (SBRs), an aerobic digester, two lined sludge storage lagoons, and 6 rapid infiltration basins (RIBs). Design and general information pertaining to the wastewater treatment plant is provided in Table 1.

Table 1 Cold Springs Wastewater Treatment Plant Specifications	
Design Average Daily Flow	0.35 Million Gallons per Day (MGD)
Design Peak Flow	0.88 MGD
Design Influent BOD	200 mg/L
Design Influent TSS	200 mg/L
Influent Pumping	Wet Pit/Dry Pit
Screening	None
Grinding	Comminutor
Grit Removal	None
Treatment Equipment	Sequencing Batch Reactors
Filtration	None
Disinfection	Liquid Sodium Hypochlorite
Effluent Pumping	Wet Well-Submersible Pump
Effluent Disposal	Rapid Infiltration Basins
Sludge Stabilization	Aerobic Digester
Sludge Dewatering	Hold in Lagoons for 1 Year+
NDEP Discharge Permit Limits	
BOD_5	30 mg/l
TSS	30 mg/l
Nitrate	10 mg/l as N

Table 2 provides summary information of the CSWWTP influent and effluent characteristics averages for the first quarter of 2001 and over the operational life of the treatment plant as of March 2001.

Table 2

Cold Springs Wastewater Treatment Plant Influent/Effluent Data

Parameter	Average Over First Quarter of 2001	Average Over Operational Life of Treatment Plant
Influent Monthly Maximum BOD_5	417 mg/L	445 mg/L
Influent Monthly Maximum TSS	266 mg/L	247 mg/L
Effluent Average BOD_5	9.3 mg/L	13.1 mg/L
Effluent Maximum TSS (mg/L)	11 mg/L	10.5 mg/L
Effluent Maximum Nitrate-N (mg/L)	<0.1 mg/L	0.017 mg/L

To keep the treatment plant out of the flood plain, it was constructed on a site approximately 1.5 miles north of White Lake. This location is approximately 35 vertical feet above lake level and is well above the flood plain. The increased elevation requires a portion of the collection system to utilize lift stations and force mains to deliver wastewater to the plant.

2.2.4 Collection System

The existing collection system was constructed along with the CSWWTP with additions completed in subsequent years. The sewer collection system consists of 8-inch PVC sewer laterals, increasing to 10-inch and 12-inch collectors as necessary. The sanitary sewer flows south and east to one of two lift stations. The Diamond Peak Lift Station (DPLS) was constructed in 1997, located approximately 3 miles south of the treatment plant, on the west side of Diamond Peak Drive, 150 feet north of Reno Park Boulevard. It is a Smith and Loveless custom series lift station capable of pumping 275 gpm.

The Woodland Village Lift Station (WVLS) was completed in the year 2000 and has a pumping capacity of 1,100 gpm. The WVLS has a wet pit/dry pit pump configuration. The invert of the wet well is approximately 35 feet below the ground surface. This lift station is located in the south-central portion of the Lifestyle/Woodland development, approximately 1.5 miles southeast of the treatment plant. The WVLS will ultimately serve the southern portion of the Lifestyle/Woodland development.

A final pump station is located at the treatment plant to lift plant influent into the treatment works.

New lift stations and collection system improvements will be constructed as necessary by developers to accommodate increased sewer flows from new construction. All new sewers and lift stations will be operated and maintained by Washoe County Utilities Division and are required to meet Washoe County design standards. The Washoe County Utility Division must approve all sewer and lift station plans and inspect the construction of these facilities.

2.2.5 Existing Effluent Disposal

The current method of effluent disposal at the wastewater treatment plant uses six rapid infiltration basins (RIBs). Plant effluent is discharged as a batch load to a basin and allowed to percolate into the soil. The RIB is then allowed to rest. This results in groundwater mounding in the soil underneath the RIBs. In a report titled *Cold Spring Valley Groundwater Investigation* (1999), Nimbus Engineers estimated the travel time for effluent from the RIBs to Utilities Inc. Well #1 to be 275 years if the effluent travels through the shallow groundwater aquifer. If the effluent travels through the lower groundwater system, the travel time to Well #1 is estimated to be greater than 1,000 years.

2.2.6 Sludge Disposal

Waste sludge from the CSWWTP is discharged to one of two lined sludge lagoons. Typical operation has the sludge lagoons covered with water to control odors. The sludge further breaks down in the lagoons. When a lagoon is full the water is drained off and the sludge slowly dries in the sun. After drying, the sludge is disposed of at the Lockwood Regional Landfill located in Storey County, Nevada. However, to date no dewatered sludge has been transported out of the Valley.

2.3 Existing Groundwater Quality and Water Table Elevations

The Cold Springs basin experiences relatively high ground water in a good portion of the areas where development has occurred. A study by Nimbus Engineers in 1999 showed the fluctuation of groundwater levels through the 1990's. During this period the Cold Springs basin experienced periods of precipitation well below and well above average. The groundwater contour of elevation 5,035 feet, approximately the elevation of the lakebed of White Lake, migrated northward as recharge amounts declined during the drought. Between 1990 and 1993 the 5,035 feet contour moved approximately 1,000 feet northward. By 1996, after two winters with above average precipitation, the 5,035 feet contour had moved approximately 2,000 feet southward. By 1999, the groundwater near White Lake had risen another 2 feet, resulting in water as close as 5 feet to the ground surface at locations within the developed subdivision. During the same period, the groundwater in the vicinity of the RIBs remained relatively constant at approximately 40 feet below ground level.

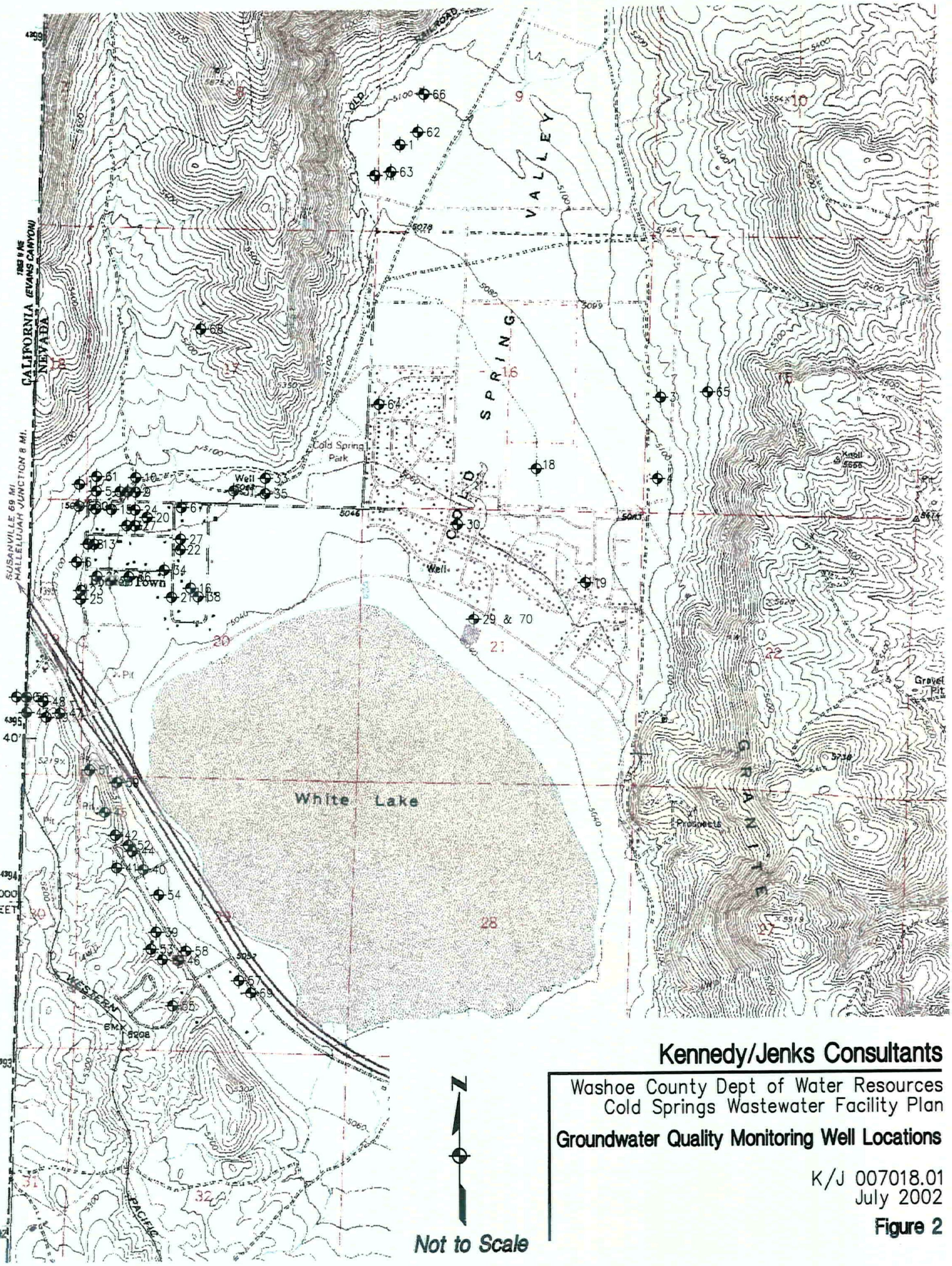
From the initial development of the Cold Springs Valley until 1996, all residences used individual septic tank/leach field systems. These systems discharge effluent to the soil, which percolates to the shallow groundwater. The increasing number of septic tanks, coupled with the rise in groundwater levels, has caused an increase in nitrate concentration of the groundwater. Groundwater sampling by Washoe County in 1991, 1997 and 2001 identified the development of a plume of nitrate contamination in the developed subdivision that now exceeds the allowable standard of 10 mg/l nitrate-N. The 1997 groundwater samples were taken from 71 existing wells. The well locations are shown in Figure 2 and the sampling data is given in Table 3. The wells included Washoe County and USGS monitoring wells; monitoring wells at the CSWWTP; Utilities, Inc. community drinking water wells and private domestic wells. The nitrate plume was centered in the vicinity of Sandpiper Drive and Cold Springs Drive and covered most of the subdivision. The maximum sampled nitrate-N level was 18.3 mg/l. Figure 4 of Part Two of this facility plan shows the limits of the nitrate plume based on groundwater monitoring conducted in 1997.

Additional groundwater sampling was conducted in the spring of 2001. Four monitoring wells were sampled including monitoring wells CSV2, CSV4, CSV5, and CSV8. The respective concentrations in mg/L nitrate-N of the samples were 33, 18, 0.84, and 1.0. The measured nitrate concentration of 33 mg/L for monitoring well CSV2 located near Nancy Gomes Elementary School was resampled. The resampling confirmed the initial nitrate concentration. This area of polluted groundwater is currently under study and Washoe County's plan to address this problem is described Part Two of this facility plan.

2.4 Existing Drinking Water Supply

2.4.1 Public Water System

The majority of the homes and businesses in Cold Springs are served potable water by Utilities, Inc., a private water purveyor. Utilities, Inc., operates four municipal wells in the basin and is considering building a fifth. Total pumping capacity for the system is 2,900 gpm. The water system has four storage tanks, with a total storage capacity of 1.2 million gallons.



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Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

Groundwater Quality Monitoring Well Locations

K/J 007018.01
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Figure 2

TABLE 3 - COLD SPRINGS WATER QUALITY DATA - 1997
XY COORDINATES IN STATE PLANE METERS, NAD83
ELEVATION IS IN NAVD29

Well No.	X	Y	NAME	Date	ELEV (FT)	STATIC (FT)	TDS	SULFATE	CHLORIDE	NITRATE	FLUORIDE
1	244853.801	4398311.049	WW2D	6/18/97	5082.33	45.52	166	45	4	0.8	0.18
2	245601.830	4399441.058	WW1D	6/18/97	5128.22	82.83	142	7	4	1.4	0.15
3	246235.806	4396892.031	CC2	6/18/97	5103.61	60.32	308	38	25	4.2	0.12
4	246175.798	4396424.026	CC1	6/18/97	5087.22	43.31	838	181	88	7.2	0.1
5	243077.958	4396300.282	JAMES	6/20/97	5060.75	23.23	162	5	4	1.3	0.15
6	242960.825	4395889.216	LESSARD	6/20/97	5068	24.54	220	4	4	1.6	0.08
7	243215.117	4396295.470	REIMER	6/20/97	5063.04	25.7	213	8	6	2.3	0.28
8	243028.547	4395992.592	ZEBAL	6/20/97	5060.88	21.97	239	5	14	2.5	0.08
9	243305.462	4396292.407	MOTT	6/20/97	5059.65	24.75	247	9	7	2.7	0.26
10	243307.776	4396378.595	TODD	6/20/97	5064.44	0	222	9	7	2.7	0.33
11	242979.988	4396341.283	JACKSON	6/20/97	5084.22	0	260	11	17	2.8	0.07
12	243260.305	4396294.032	WOODS	6/20/97	5055.42	16.82	234	10	8	3.2	0.27
13	243063.922	4395991.404	ZEBAL	6/20/97	5056.21	17.78	246	6	7	4.6	0.07
14	243074.488	4396195.594	PEREZ	6/20/97	5062.78	26.72	339	15	18	4.8	0.23
15	243165.208	4396192.531	RUDELBACH	6/20/97	5055.15	17.28	1072	308	105	24.5	0.23
16	243623.741	4395733.025	CSV8	6/23/97	5037.76	3.52	230	9	7	1	0.23
17	243300.147	4396096.780	SMITH	6/23/97	0	0	144	6	4	2	0.24
18	245572.789	4396552.029	CSV2	6/23/97	5068.17	24.44	482	29	21	10.5	0.12
19	245903.786	4395933.022	CSV1	6/23/97	5071	26.56	988	280	38	13.3	0.09
20	243371.930	4396144.280	GREEN	6/24/97	5049.76	14.41	171	6	5	2.3	0.31
21	243512.738	4395680.775	MCBRIDE	6/25/97	5040.19	10.91	182	7	4	0.8	0.17
22	243564.681	4395955.965	MUNOZ	6/25/97	5050	14.18	160	8	5	1	0.22
23	242985.979	4395725.464	HEINEMAN	6/25/97	5072.26	23.85	203	4	4	2.4	0.06
24	243302.430	4396188.093	GARCIA	6/25/97	5052.73	0	216	8	6	2.5	0.31
25	242984.666	4395675.089	FLADAGER	6/25/97	0	0	249	10	10	2.6	0.08
26	243080.232	4395805.777	SIMS	6/25/97	5061.25	0	237	7	7	4.4	0.06
27	243566.463	4396016.778	DULANEY	6/25/97	5043.14	6.84	813	252	66	9.3	0.14
28	243157.327	4395777.714	WILSON	6/25/97	5055.44	16.97	301	11	11	10.4	0.05
29	245172.706	4395734.022	CSV6	6/27/97	5039.02	3.06	642	53	29	16.7	0.33
30	245189.777	4396218.027	CSV4	6/27/97	5052.63	13.96	432	40	42	18.3	0.15
31	243875.067	4396295.031	CASEY	6/30/97	5051.44	20.74	179	11	5	1.6	0.15
32	243253.396	4396098.093	OJEDA	6/30/97	5049.07	14.57	177	7	5	2.1	0.18
33	244060.040	4396368.093	COWAN	6/30/97	5053.28	0	205	10	5	2.1	0.09
34	243470.240	4395838.589	SLATTON	6/30/97	5042.05	13.2	213	6	5	2.2	0.18

TABLE 3 - COLD SPRINGS WATER QUALITY DATA - 1997
XY COORDINATES IN STATE PLANE METERS, NAD83
ELEVATION IS IN NAVD29

Well No.	X	Y	NAME	Date	ELEV (FT)	STATIC (FT)	TDS	SULFATE	CHLORIDE	NITRATE	FLUORIDE
35	244058.289	4396277.405	CASEY	6/30/97	5047.66	8.66	207	10	5	2.5	0.13
36	243263.986	4395800.527	FULLER	6/30/97	5045.94	17.54	238	5	5	3.1	0.09
37	242976.330	4396212.969	HELM	6/30/97	5070.76	30.22	422	18	29	7.1	0.07
38	243666.835	4395683.275	MURPHY	7/1/97	5037.1	7.76	141	7	4	0	0.22
39	243413.551	4393716.755	BROWN	7/2/97	5108.25	52.93	103	6	2	0	0.12
40	243340.649	4394082.009	DANCER	7/2/97	5077.01	25.24	137	6	2	0.7	0.07
41	243186.521	4394094.010	SCOTT	7/2/97	5111.95	0	136	5	2	1	0.1
42	243180.087	4394287.512	CALL	7/2/97	5084.98	18.14	183	5	4	2.2	0.11
43	242667.869	4395009.520	WHEATLEY	7/2/97	5164.34	0	194	3	4	2.5	0.11
44	243276.900	4394191.385	LEFFINGWELL	7/2/97	5078.98	28.01	204	7	6	2.6	0.09
45	243118.712	4394419.482	MURPHY	7/2/97	5107.43	52.55	194	6	5	3.6	0.08
46	243541.208	4393546.566	LINKER	7/3/97	5097.92	34.92	214	12	4	1.7	0.11
47	242859.810	4395003.520	BOARDMAN	7/3/97	5133.23	61.6	187	3	3	2.1	0.11
48	242762.715	4395072.771	WHEATLEY	7/3/97	5177.69	103.3	195	5	5	2.4	0.11
49	242780.089	4394980.270	SILVA	7/3/97	5196.79	121.96	202	8	4	2.4	0.09
50	243450.269	4393553.253	ADELMAN	7/3/97	5118.37	49.1	234	7	4	2.9	0.1
51	243032.152	4394668.516	PRIEWE	7/3/97	5140.8	0	212	5	3	3	0.08
52	243254.493	4394227.073	FRIEDLANDER	7/3/97	5079.32	27.62	247	7	10	4.3	0.08
53	243383.518	4393615.942	DROWN	7/15/97	5134.69	80.04	124	6	2	0	0.08
54	243429.649	4393932.445	HOLST	7/15/97	5082.87	32.84	142	5	2	0.8	0.08
55	243509.141	4393279.125	GOMES	7/15/97	5107.72	25.7	221	13	4	1.6	0.19
56	242667.089	4395099.896	ANDERSON	7/15/97	5184.72	102.44	201	3	3	2.6	0.12
57	243892.869	4393425.439	HEPNER	7/15/97	5057.58	25.7	434	29	13	3.5	0.15
58	243587.897	4393602.754	ELLENA	7/15/97	5093.48	31.14	265	11	7	4.4	0.09
59	243189.748	4394593.233	KNOWLES	7/15/97	5060.92	0	257	8	6	5	0.08
60	242609.932	4395102.396	WEST	7/15/97	5161.42	80.04	288	8	11	5.4	0.21
61	243080.772	4396386.783	NELSON	8/1/97	5072.94	0	270	14	19	4.9	0.23
62	244957.804	4398384.049	WW2S	8/4/97	5085.48	45.84	342	35	14	3.2	0.72
63	244799.798	4398152.047	WW3S	8/4/97	5078.59	38.82	311	31	16	3.7	0.18
64	244723.777	4396797.034	CSV5	8/5/97	5063.55	24.54	362	55	29	0	0.16
65	246634.813	4396896.030	CC3	8/5/97	5205.36	161.66	313	30	14	4.1	0.12
66	244993.807	4398603.051	WW1S	8/12/97	5090.36	50.07	372	28	17	0.8	0.47
67	243571.903	4396199.280	JORDAN	8/19/97	5057	0	116	11	5	1.1	0.27
68	243688.015	4397244.228	MORNEAU	8/19/97	5165.96	115.96	223	17	13	4.5	0.18
69	243961.932	4393352.250	BACON	/ 0/	5055.32	23.36	256	18	9	1.9	0.18

TABLE 3 - COLD SPRINGS WATER QUALITY DATA - 1997

XY COORDINATES IN STATE PLANE METERS, NAD83

ELEVATION IS IN NAVD29

Well No.	X	Y	NAME	Date	ELEV (FT)	STATIC (FT)	TDS	SULFATE	CHLORIDE	NITRATE	FLUORIDE
70	245170.770	4395734.022	CSV7	/ 0/	5039.02	5.03	323	22	13	8.1	0.09
71	244705.796	4398132.047	WW3D	/ 2/	5076.36	39.14	182	41	5	1.1	0.15

Water consumption in the Cold Springs Valley is regulated by the Nevada State Engineer, Division of Water Resources. The Division has determined from historical data that each dwelling unit in Cold Springs is required to have 0.57 acre-feet of water per year dedicated for its use. This equates to approximately 508 gal/day/dwelling. The state engineer will entertain appeals for the reduction of this number if sufficient historical data is available to support the reduction. Data from the March 2000 Utilities, Inc. Water Master Plan indicate an historical use of 402 gallons per day per equivalent residential unit (ERU) which is equal to 0.45 acre-feet of water per year per ERU. The majority of new development in Cold Springs is expected to be served by Utilities, Inc.

2.4.2 Domestic Water Wells

Approximately 75 homes are served by private domestic water wells. These homes are located on the northwest shore of White Lake, east of US 395. By state regulation each home is entitled to draw 2.02 acre-feet of groundwater per year, or 1,800 gal/day. The homes using private domestic wells lie outside of the facility plan limits.

Section 3: Population Projection and Planning Period

3.1 Population of Cold Springs Wastewater Treatment Plant Service Area

Population projections for Cold Springs, available from Washoe County Community Development and the Regional Transportation Commission, encompass the entire basin. The Cold Springs Wastewater Treatment Plant is intended to serve only a portion of the Cold Springs basin. All homes southwest of US 395 and all homes northeast of US 395 constructed prior to 1996 use individual, on-site wastewater disposal systems. As of June 30, 2002, 669 homes were connected to the Cold Springs wastewater treatment facility. One-hundred sixty eight of these homes are in the White Lake Homes development, with the balance in the Lifestyle/Woodland development.

Using the Washoe County Water and Wastewater Design Standard (Section 3.1.2), each home is assumed to have an occupancy of 3.5 persons. This equates to a current population of 2,342 people being served by the wastewater treatment facility. Mr. Robert Lissner of Lifestyle/ Woodland anticipates constructing 20 new homes per month until completion of the Lifestyle/Woodland development in 2008. Between June 30, 2001 and June 30, 2002 an additional 257 homes were connected to the CSWWTP slightly exceeding the anticipated construction schedule. At the completion of the Lifestyle/Woodland development there will be approximately 2,070 homes in the Lifestyle/Woodland development connected to the community sewer for a service population of 7,245 people. The White Lake Homes residential development calls for a build-out total of 364 homes connected to the community sewer system resulting in an additional 1,274 people for a total of 8,519 people served. No capacity for additional development is included in the proposed wastewater treatment plant expansion because no other large scale developments are planned at this point in time thus the service population will remain relatively constant after 2008.

Population projections for the Cold Springs Wastewater Treatment Plant service area and for the Cold Springs basin based on RTC projects over the planning period are shown in Table 4. The disparity between the population projections is created because the RTC projection is based on a constant growth rate from the year 2000 through 2030, where the wastewater service area population is based on approved land use plans and the developers' anticipated growth rates. This assumption causes the wastewater treatment plant service population to increase rapidly until 2008 and then remain relatively constant for the balance of the planning period.

Table 4

Cold Springs Population Projections

Year	Cold Springs Wastewater Treatment Plant Service Area Population	Cold Springs Basin Population (RTC Data)
2006	6,062	3,956
2011	8,519	5,050
2016	8,519	6,445
2021	8,519	8,255
2030	8,519	12,760

3.2 Planning Period

This facility plan addresses the need for wastewater treatment in the Cold Springs basin for the next 20 years, through 2021.

3.3 Flow Projection

Potential wastewater flow to the Cold Springs Wastewater Treatment Plant come from various sources including the following.

- Existing and future Lifestyle/Woodland residential and commercial development and future school construction.
- Existing and future flows from the Bordertown development
- Existing and future White Lake Homes residential development.
- The existing lots with dry sewered areas (includes two separate areas).
- Lots within the facility plan limits using septic systems.
- Potential development along the north shore of Whites Lake.

The projected wastewater flows are detailed in Tables 5, 6 and 7. Table 8 presents a summary of potential flows to the CSWWTP. The Washoe County water and wastewater design standard for average annual flow is 350 gallons per day per equivalent residential unit (gpd/ERU). After discussions with Washoe County officials and consideration of existing flow conditions at the Cold Springs Wastewater Treatment Plant a maximum month average daily flow of 325 gpd/ERU was used in this facility plan in establishing design flows. This design standard has been subject to question when compared to actual flows measured at the plant and the actual flow per ERU may be significantly lower. A peaking factor of 2.5 was used on all flows to calculate the peak hour flow.

Table 5 details the portion of wastewater flow that is directly attributable to the Woodland Village tentative map and proposed town center which includes a future elementary school and middle school. Table 5 indicates an average daily flow of 0.717 MGD is attributable to existing and future development by Lifestyle/Woodland including the two new schools.

Table 5 Lifestyle/Woodland Development Wastewater Flow Projections					
Flow Source	**Data**	**ERU Count**	**Maximum Month Average Daily Flow (gallons/day)**	**Peak Hour Flow (mgd)**	**Maximum Month Flow (gallons)**
Residences at Buildout	2070 total homes	2,070	672,750	1.68	20,182,500
Commercial	50,000 square feet	33	10,725	0.027	321,750
Elementary School	12 acre site	44.5	14,463	0.036	433,890
Middle School	20 acre site	61	19,825	0.049	594,750
Total		**2,208.5**	**717,763**	**1.79**	**21,532,890**

Table 6 details the portion of wastewater flow that is directly attributable to the proposed Bordertown developments. All existing flow data and flow projections shown in Table 6 are from the Gunderson Associates' 1999 study. Table 6 indicates an average daily flow of 0.0934 MGD is attributable to Bordertown improvements. Proposed Bordertown improvements include a commercial expansion generally including a casino expansion, a new restaurant and a new hotel. Preliminary discussions with Washoe County officials have identified the commercial expansion equal to 133 equivalent residential units. Bordertown improvements also include a new residential subdivision with 171 lots. With the 133 equivalent residential units designation for the Bordertown commercial development the maximum month flow using the 325 gpd/ERU design criteria 43,225 gallons per day. Adding this to the residential flow the total projected flow for the connection of Bordertown to the community wastewater system is approximately 99,000 gallons per day based on ERU count. For planning purposes the tentative ERU value identified has been used for wastewater facility planning.

Table 6 Bordertown Wastewater Flow Projections							
	Source of Flow	Persons per Unit	Number of Units	Avg Daily Flow per Unit (gallons)	Average Daily Flow (gallons)	Peak Hour Flow (mgd)	Average Monthly Flow
Existing Casino (4,784 sq. ft.)	employees	1	10	15	150		
	customers	1	1,500	1.5	2,250		
	Total				2,400	0.006	72,000
Existing Restaurant	employees	1	45	15	675		
	meals served	1	600	5	3,000		
	Total				3,675	0.009	110,250
Proposed Casino (10,000 sq ft)	employees	1	20	15	300		
	customers	1	3,500	1.5	5,250		
	Total				5,550	0.014	166,500
Proposed Restaurant	employees	1	10	15	150		
	customers	1	400	5	2,000		
	Total				2,150	0.005	64,500
Campground	Showers	2	50	35	3,500		
	Laundry	1	15	50	750		
	Total				4,250	0.001	127,500
Future Hotel	150 Rooms	2.5	150	50	18,750	0.047	562,500
Future Mini-Mart and Gas Station	Employees	1	2	15	30		
	Customers	1	200	2	400		
	Total				430	0.001	12,900
Other Employees	Existing	1	28	15	420		
	Future	1	10	15	150		
	Total				570	0.001	17,100
Residential Development	Future	3.5	171	325	**55,575**	**0.138**	**1,667,250**
Total					**93,350**	**0.222**	**2,800,500**

Table 7 details potential wastewater flow from sources other than Lifestyle/Woodland and Bordertown. These sources include existing and future residential development of White Lake Homes, the areas with existing dry sewer lines, the area with the facility plan limits using septic systems and future development along the north shore of Whites Lake.

Table 7 Potential Cold Springs Wastewater Flows From Sources Other Than Woodland/Lifestyle and Bordertown		
Wastewater Source	**Number of Equivalent Residential Units**	**Maximum Month Average Daily Flow (MGD)**
Existing and Future White Lake Homes	364	0.118
Existing Dry sewered areas	163	0.053
Existing Septics	985	0.320
Future Development along north Shore of Whites Lake	80	0.026
Total	1,592	0.517

The flow projections presented in Table 7 for future development along the north shore of Whites Lake is based on land use planning by Washoe County and includes 10 acres of commercial development and 70 acres of residential development zoned as low density suburban which permits 1 lot per acre. This land use planning has not yet been adopted by the Washoe County Commissioners. The existing dry sewered areas presented in Table 7 are comprised of two areas as shown in Figure 1. The western area has a total of 57 lots and the eastern area has a total of 109 lots.

Table 8 presents of summary of potential flows from existing and future sources to the CSWWTP.

Table 8 Summary of Potential Flows to the CSWWTP		
Source	**ERU Count**	**Maximum Month Average Daily Flow (MGD)**
Existing and Future Lifestyle/Woodland Including Two New Schools and Some Commercial Development	2,208	0.717
Existing and Future Bordertown Commercial	133	0.043
Future Bordertown Residential	171	0.056
Existing and Future White Lake Homes	364	0.118
Existing Dry Sewered Area No. 1	57	0.019
Existing Dry Sewered Area No. 2	109	0.035
Existing Area Within the Facility Plan Limits Using Septic Systems	985	0.320
Future Commercial Development Along the North Shore of Whites Lake	10	.003
Future Residential Development Along the North Shore of Whites Lake	70	.023
Total	4,107	1.334

The potential flows listed in Table 8 include both existing and future flows. The existing CSWWTP has a treatment capacity of 0.35 MGD and was based on a flow rate of 350 gpd/ERU meaning the plant was designed for 1000 ERU's. The 1000 ERU's are split between Lifestyle/Woodland and White Lake Homes with 636 ERU's allocated to Lifestyle/Woodland and 364 ERU's allocated to White Lake Homes.

Section 4: Treatment Plant Design Criteria

4.1 Hydraulic Capacity

The proposed expansion of the Cold Springs Wastewater Treatment Facility was based on 325 gallons per day per equivalent residential unit (ERU) as a maximum month average daily flow. The Washoe County design standard for average annual flow is 350 gal/day/ERU. The deviation from the design standard was approved by the Washoe County Utility Division based various considerations. Using the 325 gpd/ERU value results in a potential sanitary sewage flow of 1.334 MGD which is 0.98 MGD greater than the existing CSWWTP capacity of 0.35 MGD The approximate 1 MGD expansion naturally lends itself to two expansions of 0.5 MGD each. Concern exists that 325 gpd/ERU value as a maximum month average daily flow is excessive and actual treatment plant flows may be substantially lower than projected. Flow data from similar residential development in Sun Valley, NV indicated the average daily flow per ERU is 225-250 gallons (Washoe County, 2000). Flow to the Cold Springs Wastewater Treatment Plant in March, 2001 averaged approximately 43,000 gallons / day from 333 service connections. This equates to an average wastewater flow of 130 gal/day/ERU. Since the observed flow per residence at the CSWWTP is considerably less than the 325 gpd/ERU design standard a 10% discount of the 1 MGD treatment capacity increase was applied resulting in a possible total expansion of 0.9 MGD constructed in two 0.45 MGD expansions.

4.1.1 Design Flow

The design flow to the treatment plant for first phase expansion is 0.80 MGD.

4.1.2 Design Peak Hourly Flow

A peaking factor of 2.5 was used to establish the peak hour flow (PHF). This equates to a PHF of 2.0 MGD.

4.2 Organic Capacity

The treatment plant expansion alternatives were designed to treat wastewater to meet the current discharge requirement of 30 mg/l biochemical oxygen demand (BOD) and 30 mg/l total suspended solids (TSS).

Analysis of CSWWTP influent over time indicates a range of 0.16 to 0.19 pounds BOD per person per day. The lower value is based on an occupancy rate of 3 people per residence and the higher value is based on an occupancy rate of 3.5 people per residence. Using the planning criteria of 325 gpd/ERU and 220 mg/L (BOD) results in an estimated range of 0.17 to 0.20 pounds BOD per person per day based on 3.0 and 3.5 people per residence respectively. Metcalf & Eddy (1979) show a typical value of 0.22 lbs/person/day BOD_5 with food grinders, and 0.18 lbs/person/day without food grinders.

4.2.1 Design Average BOD

The design average BOD_5 is 220 mg/l. Based on the first phase design flow of 0.8 MGD this equates to a total residential loading of 1470 lbs / day of BOD. This value includes the flow from the Bordertown Casino and other commercial development. Further discussion of this subject is presented in Section 7.

4.2.2 Design Average TSS

The design total suspended solids is 220 mg/l. Based on the design flow of 0.8 MGD this equates to a daily loading of 1470 lbs TSS.

Table 9 summarizes the hydraulic and organic design criteria for Phase One expansion of the Cold Springs Wastewater Treatment Plant.

Table 9

Phase One Expansion Treatment Plant Hydraulic and Biological Design Criteria

Item	ERU	Criteria	Total
Maximum Month Average Daily Flow	2,461	325 gpd/ERU	0.80 MGD
Peak Hour Flow	2,461	2.5 * peak factor	2.0 MGD
Influent BOD	n/a	220 mg/l	1,470 lbs/day
Influent TSS	n/a	220 mg/l	1,470 lbs/day

Section 5: Treatment Plant Expansion Alternatives

5.1 Unit Process Alternatives and Evaluation

The Cold Springs Wastewater Treatment Facility will need to be expanded in the future to accommodate the development in the basin. An initial expansion to a rated capacity of 0.80 MGD was investigated. Kennedy/Jenks Consultants performed a detailed study of the existing wastewater treatment plant and several expansion alternatives. Table 10 lists the various treatment processes investigated.

Table 10

Treatment Plant Expansion Alternatives

Process	Options Evaluated
Screening	Rotary, Perforated Basket, Traveling
Grit Removal	Horizontal Channel, Aerated Chamber, Vortex
Secondary Treatment	SBR, Oxidation Ditch, Conventional Activated Sludge, Membrane Bioreactor, Package Plants (Aero-Mod and Biolac)
Disinfection	Chlorine, Ultra-violet
Sludge Stabilization	Aerobic Digestion, Anaerobic digestion, Autothermal Thermophilic Aerobic Digestion (ATAD)
Sludge Dewatering	Sludge Lagoons, Drying Beds, Mechanical Dewatering, Filter Block Beds

Each of the processes shown in Table 10 were evaluated for feasibility and compatibility with the existing treatment plant. Evaluation categories including capital and O&M costs, effluent and sludge quality, expandability and flexibility, treatment efficiency, land requirement, aesthetics, and odor concerns were used in ranking the unit process alternatives. A summary of the evaluation and the ranking for the various unit processes along with the secondary treatment alternatives (discussed in the following sections) are included in Table 11.

5.2 Secondary Treatment Expansion and Upgrade Alternatives

There were five alternatives for expansion and/or upgrade considered appropriate for this application. These alternatives are 1) additional SBRs, 2) an oxidation ditch, 3) conventional activated sludge, 4) membrane bioreactors, and 5) a package-type plant.

5.2.1 Additional SBRs

The existing SBRs at the CSWWTP are classified as extended aeration due to the long HRT for which this process was designed. Extended aeration has been widely used for wastewater systems with relatively small flows (< 1 MGD). Extended aeration operates very effectively over widely varying flow and waste loads, common with small wastewater systems, because the high microorganism concentration and long HRT dampen the impact of those variations.

Table 11 - Summary and Ranking of Wastewater Treatment Plant Expansion Alternatives

Alternative	Opinion of Probable Capital Cost	Opinion of Probable Annual O&M Cost	Opinion of Probable Present Worth	Effluent/ Sludge Quality	Expandability/ Flexibility	Treatment Efficiency	Land Requirement	Aesthetics	Odor Concerns	Rank
Screening										
Perforated Basket	$110,000	$4,900	$180,000	4	2	4	5	4	4	1st
Rotary	$130,000	$5,000	$200,000	4	2	3	4	4	4	2nd
Traveling	$120,000	$4,800	$190,000	4	2	3	4	3	2	3rd
Grit Removal										
Horizontal-Flow	$20,000	$1,500	$45,000	2	2	3	3	4	3	2nd
Aerated Chamber	$100,000	$6,100	$190,000	3	2	2	3	3	4	3rd
Vortex	$110,000	$4,900	$180,000	4	2	4	4	2	4	1st
Secondary Treatment										
SBRs	$1,530,000	$38,000	$2,100,000	4	5	3	4	3	4	1st
Oxidation Ditch	$1,790,000	$35,000	$2,300,000	4	4	4	3	2	4	3rd
Conventional A/S	$1,800,000	$56,000	$2,600,000	4	4	3	3	2	4	4th
MBR	$2,800,000	$60,000	$3,700,000	5	5	4	5	5	5	6th
Biolac	$1,410,000	$60,900	$2,300,000	3	3	4	2	4	3	2nd
Aero-Mod *(1)*	$1,730,000	$64,000	$2,700,000	3	4	3	4	2	4	5th
Disinfection										
Chlorine *(2)*	$180,000	$17,000	$430,000	5	3	4	3	3	5	2nd
UV	$170,000	$9,000	$300,000	4	4	4	5	5	4	1st
Effluent Disposal										
Rapid Infiltration	$800,000	$9,000	$930,000	4	2	4	2	4	3	1st
Effluent Reuse *(3)*	$690,000	$29,000	$1,120,000	5	4	3	4	3	5	3rd
Wetlands	$930,000	$8,000	$1,050,000	4	2	4	2	5	2	2nd
Sludge Stabilization										
Aerobic Digestion	$350,000	$16,900	$600,000	3	4	3	3	3	4	1st
Anaerobic Digestion	$600,000	$14,300	$810,000	4	3	4	4	4	3	3rd
ATAD	$310,000	$19,800	$690,000	5	5	3	5	5	4	2nd
Sludge Dewatering										
Sludge Lagoons	$110,000	$3,700	$170,000	4	2	3	2	2	1	4th
Drying Beds	$120,000	$7,500	$230,000	5	2	4	3	2	3	3rd
Centrifuge	$380,000	$11,800	$560,000	4	5	4	5	5	5	1st
Filter Screen Blocks	$150,000	$9,400	$520,000	4	3	4	4	3	4	2nd

Scoring:	1	2	3	4	5
	Very Poor	Poor	Fair	Good	Very Good

Notes:

1 Less mechanical equipment could reduce the overall cost of the entire facility by reducing the size of the equipment building.

2 Includes modifications to the existing contact chamber, but excludes the cost of dechlorination.

3 Excludes the cost of distribution and storage.

With extended aeration processes such as SBRs and oxidation ditches, raw wastewater typically receives only preliminary treatment (e.g., grinders, comminutors, screens, and grit removal), as is the case at the CSWWTP. Primary treatment (i.e., settling of "raw" wastewater) is not usually included with extended aeration. Instead, the "raw" solids are processed aerobically in the extended aeration process. For small treatment plants, this is almost always less expensive than constructing primary clarifiers and aerating or stabilizing the "raw" settled solids separately. Extended aeration has a relatively low waste loading rate, which generally provides sufficient treatment capacity without primary treatment.

The existing SBR process is a non-steady state activated sludge process in which each of two basins are filled with wastewater and operated in a batch treatment mode. The operation of the two basins are staggered such that one is always available to receive flow. The process involves a fill-and-draw, complete mix reactor where both aeration and clarification occur in a single reactor, whereas conventional continuous flow processes require multiple structures and additional pumping and piping. The reactor progresses through a series of discrete phases using programmable functions and time intervals. The mixed liquor remains in the reactor during all phases of operation, which are as follows:

- Fill – the reactor is filled with wastewater. As wastewater enters the reactor, it is mixed with biological organisms, or activated sludge, resulting in mixed liquor. During the fill phase the reactor may be aerobic or anoxic (i.e., absence of oxygen). During anoxic fill, the reactor is mixed without the use of aeration. A recirculation pump mixes the contents of the reactor by recirculating mixed liquor. An anoxic fill can function as a selector to assist in controlling filamentous bacteria. Filamentous bacteria have characteristics that make them difficult to settle and, therefore, can negatively impact effluent quality. Creating an anoxic environment favors or "selects" the growth of floc-forming bacteria which, unlike filamentous bacteria, can grow under anoxic conditions and have much better settling characteristics.

- React – influent wastewater flow to the reactor is terminated. Plant influent is diverted to the second reactor. Aeration and mixing are accomplished using jet aeration. Liquid and air piping and jet nozzles form a jet aeration header. Air supplied by a blower is mixed with recirculated mixed liquor and delivered through the jet nozzles to accomplish both aeration and mixing. The supply of air introduces oxygen into the reactor to create aerobic conditions. The recirculation of mixed liquor maintains a completely mixed reactor. Oxygen introduced into the mixed liquor is used by aerobic microorganisms to metabolize the dissolved and colloidal organic wastes in the wastewater.

  - Oxygen is also used to convert ammonia to nitrate through a process known as nitrification. Nitrification occurs significantly slower than oxidation of organic matter and requires approximately four times the amount of oxygen. Therefore, sufficient oxygen, a long solids retention time (SRT), and a long HRT must be maintained or nitrification will slow dramatically or cease. A long SRT increases the microorganism population, thereby increasing the nitrification capacity. A long HRT increases the contact time between the wastewater and the microorganisms, allowing more time for nitrification.

  - Converting ammonia to nitrate does not constitute removal of nitrogen, but it does eliminate its oxygen demand. Nitrogen removal is accomplished through a process known as denitrification, which converts nitrate to nitrogen gas. Nitrogen gas is then removed to the atmosphere through gas transfer. Denitrification is accomplished under anoxic conditions, because the presence of dissolved oxygen (DO) suppresses the enzyme needed for denitrification. To create anoxic conditions in the reactor, the blower is turned off, but the recirculation pump remains active to keep the contents of the reactor mixed.

- Settle – mixing and aeration cease. Solids/liquid separation takes place under quiescent conditions.
- Draw – the mixing and aeration systems remain off. Effluent is withdrawn from just below the liquid surface by means of a decanter. The decanter floats to allow shorter settling periods and variable decant levels, Grease, scum, and other floating solids are largely excluded from the effluent because the decanter withdraws effluent from below the liquid surface.
- Waste – settled sludge is wasted from the bottom of the reactor to maintain the operating solids retention time (SRT). Because the microorganisms multiply as they metabolize organic waste, microorganisms must be wasted as sludge to prevent an excessive buildup, which would affect the quality of effluent. After wasting, the reactor is ready to repeat the cycle. The draw and waste phases can be combined to reduce the cycle time.

Each SBR has a volume of approximately 175,000 gallons, for a total volume of 350,000 gallons. The average design flow, which corresponds to the average wet weather flow, is 350,000 gallons per day (gpd). Therefore, the SBRs were sized to maintain a minimum HRT of 1 day or 24 hours, which is typical for an extended aeration process. The SBRs are also designed to achieve an SRT of 45 days at a mixed liquor suspended solids (i.e., activated sludge) concentration of 3,000 mg/l. The SBR process operates using a complex program run by a microprocessor control system. The control system consists of a PLC and graphical user interface.

The SBRs have been operating well, achieving typical effluent concentrations of TSS and BOD_5 of less than 10 mg/l and total nitrogen (TN) less than 1 mg/L. These concentrations are well below the effluent discharge requirements for the CSWWTP, which are 30 mg/l TSS, 30 mg/l BOD_5, and 10 mg/l TN.

SBRs can be added to the existing CSWWTP to increase capacity for secondary treatment. This would require constructing additional reactors and one or more additional process and control structures to house the accompanying mechanical and control equipment.

5.2.2 Oxidation Ditch

In an oxidation ditch, mixed liquor is transported around an oval pathway by rotors, brushes, or other mechanical aeration devices located at one or more points along the flow circuit. Jet aeration devices and combinations of diffused aeration and submersible mixers have also been used. Rotors are most commonly used to maintain tank motion and aerate the contents of the ditch. Blades, plastic bars, angle steel, or other steel shapes are mounted on the rotor cylinder to promote circulation and entrain air in the mixed liquor as the assembly rotates. Agitating the water surface also enhances the air-water interface, helping to further increase the concentration of DO in the mixed liquor. Generally, oxidation ditches are custom designed for each application.

As mixed liquor passes the rotors, the DO concentration rises sharply but declines as flow traverses the circuit. Depending on the relative locations of wastewater influent, removal of effluent, sludge return, and aeration/mixing equipment, oxidation ditches can achieve nitrification and denitrification in addition to oxidation of organic waste. To achieve nitrification in addition to oxidation of organic waste, influent is typically introduced into the circuit near the rotor, and effluent exits upstream of the influent. The process can be modified to perform denitrification with proper control of the DO. DO control ensures sufficient DO for oxidation and nitrification, but limits excess supply. Minimizing excess DO prompts the formation of anoxic zones after sufficient travel time around the circuit, when oxygen uptake from the biomass begins to deplete the supply of DO. The location and size of the anoxic zones vary due to changing wastewater quality and flow. The DO control system adjusts oxygen transfer accordingly to accomplish oxidation of organics, nitrification, and denitrification. The rotors also supply mixing energy to keep the biomass in suspension.

Rates of nitrification and denitrification in the system described above are typically low because the resulting low DO concentrations are not ideal for either nitrification or denitrification. Furthermore, low DO concentrations promote the growth of filamentous bacteria. However, the high concentration of mixed liquor and long HRT provide adequate time for nitrification and denitrification to occur. Oxidation ditches are an extended aeration process with HRTs typically in the range of 18 to 24 hours. Oxidation ditches are generally designed for an SRT between 10 and 30 days with concentrations of mixed liquor suspended solids of 2,500 to 5,000 mg/l. Nitrogen removals higher than 90% have been reported using oxidation ditches.

A variation of the process described above operates the oxidation ditch in distinct aerobic and anoxic phases for improved denitrification and better control of filamentous bacteria. As with the previous process, the rotors supply mixing and aeration for oxidation of organics and nitrification during the aerobic phase. However, denitrification is accomplished in a separate operation phase. For a period of usually 6 to 8 hours each day, the rotors are turned off and a submersible mixer is activated to keep the biomass in suspension without aeration. As a result, the entire oxidation ditch becomes anoxic, creating ideal conditions for denitrification. Because the oxidation ditch is a continuous process, the nitrate concentration in the effluent fluctuates, since denitrification is intermittent. However, the composite concentration of nitrate in the effluent is low. The anoxic phase can be timed to coincide with the period of highest flows to maximize the growth of new biomass under anoxic conditions. This mode of operation favors the growth of non-filamentous bacteria for improved settleability.

In some applications, a phased operation scheme has been applied to two or more oxidation ditches to accomplish nutrient removal. Such a system allows operation of one or more oxidation ditches in a permanent anoxic state, or longer periods for operating in an anoxic phase due to greater capacity for secondary treatment with more than one oxidation ditch. This configuration provides the operator with more flexibility to control the length of the aerobic and anoxic phases compared with operation of a single oxidation ditch.

Effluent from the oxidation ditch typically flows by gravity into a splitter box where the flow is split between two or more secondary clarifiers. Secondary clarifiers are generally either rectangular or circular shaped concrete structures. The most common are circular clarifiers, of which there are two types 1) rim feed and 2) center feed. Center feed are by far the most common because they are the simpler to operate and maintain.

Secondary clarifiers provide a quiescent environment allowing the activated sludge to separate from the mixed liquor. Mixed liquor is transported through a feed line rising up from the center of the clarifier into an energy dissipating inlet and flocculating center well. The energy dissipating inlet distributes flow and reduces density currents to prevent short circuiting and minimize disturbances to the sludge blanket. The flocculating center well promotes flocculation of discrete particles for improved settling and solids removal. Flow from the center feed line enters a chamber in the energy dissipating inlet and exits through tangential control gates, which diffuse flow into the flocculating center well and impart a rolling action to promote flocculation. A homogeneous underflow is achieved downward through the flocculating center well. Flocculent particles form a viscous sludge blanket at the bottom of the clarifier while clarified effluent rises into the overlying clear water zone. Clarified effluent overflows a weir around the perimeter of the tank and collects in the effluent launder where it is discharged to disinfection. Design overflow rates for extended aeration are 1,000 gpd/ft^2 based on the Ten States Standards.

In the lower zone, the sludge blanket thickens and settled activated sludge is collected in a central hopper in the bottom of the clarifier. A scraper mechanism is used to plow settled activated sludge towards the central hopper where it is continuously returned to the oxidation ditch as return activated sludge (RAS) to maintain sufficient biomass in the oxidation ditch. Periodically, activated sludge will be wasted from the process cycle to control the SRT in the oxidation ditch. The waste activated sludge is generally pumped to a sludge digestion process for stabilization.

Scum that floats on the water surface within the clarifier is removed using a rotating skimming blade. The skimming blade collects scum on the water surface as it is rotated around the clarifier. A scum box traps the collected scum as the skimming blade passes. Scum is typically pumped to the sludge digestion process.

5.2.3 Conventional Activated Sludge

A conventional activated sludge process consists of rectangular aeration basins supplied with diffused air and secondary clarifiers. As with an oxidation ditch, settled activated sludge from secondary clarifiers is pumped back to the aeration basins to maintain an appropriate concentration of mixed liquor suspended solids for treatment.

Air supplied by blowers is generally distributed through a diffuser grid that is fixed to the bottom of the aeration basin. Diffused air is used to mix the contents of the basins and supply oxygen for oxidation of organics and nitrification. The diffusers disperse the air into the aeration basin in the form of bubbles. The bubbles may be classified as either fine or coarse depending on their size and the type of diffusers used. Fine bubble diffusers are generally thought to be more efficient because they disperse the air into smaller bubbles which increases the air/water interface and results in greater oxygen transfer into the mixed liquor. The aeration basins are typically equipped with DO probes, which are used to control the blowers based upon the measured DO concentration.

The most common types of fine bubble diffusers are ceramic fine bubble diffusers and ethylene propylene diene monomers (EPDM) fine bubble diffusers. The EPDM fine bubble diffusers tend to be more common in newer installations because they have several advantages over the ceramic fine bubble diffusers. The EPDM fine bubble diffusers save power because they have less headloss than the ceramic fine bubble diffusers. They also do not require periodic cleaning to maintain their oxygen transfer efficiency, as do the ceramic fine bubble diffusers, which tend to plug and require more horsepower to pump air through them. However, the EPDM fine bubble diffusers usually cost more than the ceramic fine bubble diffusers.

Baffle walls are often used to create an anoxic zone, typically at the head of the aeration basin, to achieve denitrification. The anoxic zone is generally located at the head of the aeration basin because the influent wastewater provides a carbon source for denitrification. Because the anoxic zone precedes the aerobic zone, the influent wastewater is not nitrified until after it passes through the anoxic zone. Therefore, internal recycle pumps are generally used to return oxidized and nitrified mixed liquor to the head of the aeration basin to pass through the anoxic zone for denitrification. The anoxic zone is typically mixed with a mechanical mixer to keep the biomass in suspension and in contact with the organic waste. No aeration is provided in the anoxic zone. The aerobic zone is mixed and aerated with diffused air.

Conventional activated sludge is typically not used as an extended aeration process, although the typical HRT is often increased to accommodate nitrification. Typical HRTs for conventional activated sludge processes with nitrification range from 6 to 15 hours. Conventional activated sludge processes with nitrification are generally designed for an SRT between 8 and 20 days with concentrations of mixed liquor suspended solids of 1,500 to 3,500 mg/l. Because this is not an extended aeration process, it may be more vulnerable to wide fluctuations in influent wastewater quantity and quality common to smaller wastewater systems. However, a shorter HRT reduces the volume of the aeration basin and the size of equipment.

5.2.4 Membrane Bioreactor

The membrane bioreactor process depends upon the same biological functions for wastewater treatment as conventional activated sludge. However, a membrane bioreactor is capable of providing the same level of treatment as a conventional tertiary treatment facility, but with significantly fewer process steps. The membrane bioreactor process uses permeate pumps to create a vacuum (2 to 9 psi typical) that pulls effluent into hollow-fiber membranes, leaving solids behind in the bioreactor. As a result, mixed liquor suspended solids are retained in the bioreactor, eliminating the need for secondary clarification and return sludge pumping. Because the mixed liquor suspended solids remain in the bioreactor, except when wasted to control the SRT, the concentration of mixed liquor suspended solids can be much higher (10,000 to 15,000 mg/l) than other activated sludge processes. This increases the treatment capacity of a given reactor or basin. A typical HRT for a membrane bioreactor with nitrification and denitrification is 3 to 6 hours. Because the hollow-fiber membranes provide microfiltration, the resulting effluent is tertiary quality effluent, requiring only disinfection for effluent reuse applications. This process eliminates the need for separate coagulation/filtration for reuse.

Since sludge age is controlled by wasting directly from the bioreactor, the sludge age can be much longer (30+ days typical) than most activated sludge processes. A longer sludge age allows the formation of more complex microorganisms which benefit treatment and tend to be more filterable. Small membrane bioreactor facilities have been know to operate at with a sludge age of 100+ days to perform both secondary/tertiary treatment and aerobic digestion in the bioreactor.

As with conventional activated sludge, the membrane bioreactor process can be divided into anoxic and aerobic zones to perform oxidation of organics, nitrification, and denitrification. As with conventional activated sludge processes, the anoxic zone is placed in front of the aerobic zone so the influent wastewater can be utilized as a carbon source for denitrification. Therefore, nitrified wastewater is recycled from the aerobic zone to the anoxic zone for denitrification.

The hydraulic capacity of the process is dependent on the membrane flux. Flux is defined as the flow of water per unit area of membrane. A typical average operating flux for the membranes is 10 to 15 gallons per square foot per day (gfd). Therefore, a higher design flow requires more membranes to maintain a certain flux. The membranes are bundled into "modules" which are grouped together in "cassettes." The cassettes are connected by a header to a permeate pump and submerged in the bioreactor.

A critical operational concern with membrane bioreactors is membrane fouling. The membranes must retain their permeability to continue to filter wastewater. The membrane bioreactor process utilizes two cleaning mechanisms to control fouling: air scour and effluent backwashing. A fixed amount of air is supplied through coarse diffusers at the base of the cassettes causing the membranes to move as air bubbles wind their way to the surface. Because the membranes are bundled close together, this movement causes them to rub against one another, scouring the membrane surface. Supplemental air is added as needed for biological treatment through a separate diffuser system. Air scouring is coupled with an effluent backwash at frequencies ranging from 15 to 30 minutes for approximately 30 to 45 seconds. A portion of the effluent is diverted to a storage tank for backwashing. During low flow periods, an extended (1 hour) backwash is often performed as a routine maintenance clean to help maintain membrane permeability.

On occasion, a recovery cleaning will need to be performed to resurrect membrane permeability. This requires removing the membranes one at a time from the bioreactor and placing them in a tank filled with a chlorine solution for a period of at least 24 hours. Spare membranes are typically installed so there is no reduction in treatment capacity during the recovery cleaning.

5.2.5 Packaged-Type Plant

A traditional package plant is one in which a manufacturer provides a complete and ready-to-operate secondary treatment process that does not require the construction of tanks or basins. The tanks or basins are supplied as part of the package. Package plants typically do not include preliminary treatment or disinfection, so most are not a complete treatment plant, but they generally offer a complete secondary treatment process. Some also offer sludge stabilization as part of the package. The traditional package plants are offered for applications with small flows (i.e., <100,000 gpd). At larger flows, the size of the tanks or basins prohibits manufacture of a traditional package plant. However, manufacturers also offer equipment packages that are often thought of as package plants for larger flow applications. These equipment packages require construction of separate tanks or basins for installation due to their size, but all equipment necessary to operate the process is provided by a single manufacturer. By this definition, SBRs are also a sort of package-type plant. Equipment packages installed in separately constructed concrete tanks or earthen basins serve as a package-type plant.

Two popular package-type plants for larger applications are the Parkson Biolac® system and the Aero-Mod® system. The Biolac® system has been used to treat both domestic and industrial wastewater with flow rates between 50,000 gallons per day (gpd) and 1.5 MGD. The Biolac® system is designed as a low organically loaded, activated sludge process. The system provides extended aeration in a lined earthen basin using floating aeration chains to supply air to the mixed liquor. Clarifiers are integrated into the end of the basin opposite the influent.

The floating aeration chains span the entire aeration basin. The aeration chains are constructed of flexible high density polyethylene tubing which floats on the water surface. Fine bubble diffusers are attached to the flexible tubing and suspended above the basin floor. The aeration chains are anchored on both sides of the basin and connected to an air header. Air is introduced at either one or both ends of the aeration chains. Air traveling through the flexible tubing and into the fine bubble diffusers oxygenates and mixes the wastewater. Because the aeration chains are constructed of flexible tubing, air released from the diffusers causes the chains to oscillate back and forth in a recurring pattern. The oscillation of the aeration chains provides supplemental mixing. The chains are evenly spaced so that the entire basin floor is covered by these oscillating patterns.

The typical Biolac® system includes a rectangular clarifier for separating and recycling activated sludge. The clarifier is constructed of concrete, with the exception of a floating partition wall, which separates it from the basin. A sloped back wall and flocculating rake mechanism traveling the length of the clarifier are used to promote settling into a hopper at the bottom of the clarifier. Settled solids are either wasted to control the concentration of mixed liquor suspended solids and SRT, or are returned to the front of the basin. Effluent leaves the clarifier through a floating weir, allowing the liquid level in the aeration basin to fluctuate.

The Biolac® system performs denitrification by utilizing "wave oxidation," which controls the air flow to each aeration chain so that some chains operate at a very low air flow while others operate at a high air flow, promoting several aerobic and anoxic zones within the basin at the same time. This allows biological nitrification and denitrification to occur simultaneously within the basin. Timers are used to cycle the air flow to each aeration chain, creating a moving "wave" of changing aerobic and anoxic zones. The moving "wave" creates contact with the proper biology for oxidation, nitrification, and denitrification without internal recycle.

The Aero-Mod® system relies on customary biological treatment mechanisms for extended aeration, but the equipment and layout of the process are unique. Flow enters a selector tank where raw wastewater is combined with RAS from the clarifiers. The selector tank is designed to control filamentous bacteria to improve settling in the clarifiers. The mixed liquor then flows into two separate continuously aerated basins, where oxidation and nitrification are achieved. The SEQUOX™ process includes a pair of second-stage aeration basins, following the first stage of continuous aeration that are cycled through a sequence of settling and reaeration to achieve denitrification. Air supply to the second stage aeration basins is alternated between the two basins to produce corresponding aerobic and anoxic conditions for denitrification. At the end of the settling phase, the oxygen-depleted biomass is mixed with the nitrified wastewater as reaeration begins, thus allowing the biomass to use nitrate as a source of oxygen before the DO concentration rises to a sufficient concentration. Additional oxidation and nitrification also occur during reaeration. The cycle is repeated several times as the mixed liquor progresses through the second stage. The biological reactions are controlled by sequencing the aeration and settling phases of operation. Sequencing is performed with simplified timers and controls.

Diffusers mounted on the side walls of the aeration basins supply the air. The diffusers are accessible using a slide rail system, which allows their removal without draining the tank or shutting off the blowers. Diffuser assemblies include two to six coarse bubble diffusers mounted to a common slide rail system. Fine bubble diffusers may be mixing limited, and therefore coarse bubble diffusers are usually used. The coarse bubble diffusers supply more mixing energy, but they are much less efficient at transferring oxygen into the mixed liquor.

Treated wastewater flows from the aeration basins into two clarifiers for separation of solids from the effluent. The patented ClarAtor® clarifier has no moving parts below the water surface. The clarifier uses common wall construction with the aeration basins, resulting in a reduced footprint and construction cost. Influent to the clarifier is drawn from the surface of the aeration basins through inlet screens and distributed across the lower portion of the clarifier. Settling occurs in a quiescent environment because the clarifier contains no moving scrapers. Uniform distribution of the wastewater reduces the potential for hydraulic short circuiting. Stationary hydraulic suction hoods along the floor of the clarifier remove settled solids from the bottom of the clarifier. Air lifts attached to the tops of the hydraulic hoods provide suction for sludge removal. The RAS is discharged back into the selector tank. Submerged weirs draw effluent from the surface of the clarifier and discharge it through a flow regulation system. The effluent flow regulation system includes some in-basin surge capacity to process moderate peak flows. Hydraulic surge control is accomplished by a triple weir device located in the clarifier effluent box. The triple weir device controls the rate at which the clarifier will pass effluent by "capping" the upward velocity independent of the influent flow. The first weir sets the minimum level at which the clarifier will pass effluent. The second weir is a submerged orifice which freely passes any flow up to the rated capacity, at which point the second weir begins restricting flow and the first weir becomes submerged. If a prolonged or abnormally high influent flow occurs, the surge capacity becomes fully utilized, and effluent overflows the third weir as a bypass of the first and second weirs, avoiding further surging. When the influent flow subsides and the water level drops below the third weir, the remaining wastewater stored above the normal operating level is processed at the normal rate. A separate surge tank is required if the aeration basins cannot equalize the expected influent flow. The effluent launders are submerged to prevent floating solids, such as scum and grease, from being discharged with the effluent. Floating solids can be removed by skimmers.

Sludge can be wasted from the aeration basins (first stage aeration basin for SEQUOX™) to an aerobic digester, which is typically integrated into the Aero-Mod® layout. Supernatant from the digester is returned to the aeration basins.

5.2.6 Aeration Pretreatment

Pretreatment aeration in an aerated pond was proposed by Lifestyle/Woodland to reduce BOD_5 loading into the SBRs. As discussed previously, the actual concentrations of BOD_5 in the influent wastewater can be in excess of 500 mg/l, which is significantly greater than the design value of 200 mg/l. Consequently, the hydraulic capacity of the SBRs will likely be reduced from the design value of 350,000 gallons per day, so as not to exceed the design BOD_5 loading capacity of the SBRs. The intent of the aerated pond is to reduce the concentrations of BOD_5 into the SBRs to maintain the hydraulic capacity of the SBRs at or nearer the design value of 350,000 gpd.

Lifestyle/Woodland estimates that the cost of an aerated pond preceding the two existing SBRs would be approximately $660,000. They indicate that maintenance on an aerated pond would consist of occasional maintenance on the aerators, but would not require removal of sludge on a regular basis, since the pond would be completely mixed. It is also explained that an aerated pond could serve to equalize flow ahead of the SBRs and offer temporary storage in case of a release of toxic materials into the tributary collection system.

While there is no doubt that an aerated pond would reduce the concentrations of BOD_5 into the SBRs, there are reasons why this alternative should not be implemented. SBRs rely on inert material and heavier organic particles present in raw wastewater to improve the settling characteristics of the mixed liquor. Many of those inert materials and heavier organic particles would be removed or settle out in an aerated pond, thereby affecting the performance of the SBRs by reducing settleability. Furthermore, algae would be generated in the aerated pond and would not be removed in the SBRs, because the density of algae is very close to that of water. Both the presence of algae and the removal of inert and heavier organic particles would have a detrimental affect on the performance of the SBRs and increase the TSS concentration in the effluent. For these reasons, it is not recommended that an aerated pond be constructed ahead of the SBRs.

Additionally, it is recommended that an aerated pond not be operated in parallel with the SBRs. An aerated pond would likely have difficulty nitrifying wastewater in the winter months because of the low reaction rates resulting from low ambient temperatures and the lack of control the operators have over this type of process. Consequently, an aerated pond would probably not meet the total nitrogen limit for effluent discharge during the winter months.

5.3 Secondary Treatment Alternative Evaluation

The five alternatives evaluated for expansion of secondary treatment at the CSWWTP were: 1) additional SBRs, 2) oxidation ditch, 3) conventional activated sludge, 4) membrane bioreactor, and 5) package-type plant. These alternatives were compared based on the following evaluation criteria. Table 11 presents a summary of the evaluation and ranking of the secondary treatment alternatives considered.

5.3.1 Costs

The probable capital costs for additional SBRs, an oxidation ditch, conventional activated sludge, MBR, Biolac® system, and Aero-Mod® system are $1.53 million, $1.79 million, $1.80 million, and $2.80 million, $1.41 million, and $1.73 million, respectively, based on an ADF of 0.45 MGD. The probable annual O&M costs for additional SBRs, an oxidation ditch, conventional activated sludge, MBR, Biolac® system, and Aero-Mod® system are $38,000, $35,000, $56,000, $60,000, $60,900, and $64,000, respectively. The resulting probable life cycle costs for additional SBRs, an oxidation ditch, conventional activated sludge, MBR, Biolac® system, and Aero-Mod® system are $2.1 million, $2.3 million, $2.6 million, $3.7 million, $2.3 million, and $2.7 million, respectively. Additional SBRs and the Biolac® package-type plant appear to be the least cost alternatives for expansion of the secondary treatment process, based on a life cycle cost comparison of probable present worth. Although the Biolac® package-type plant appears to have the least probable capital cost, the method and volume of aeration requires significantly more energy, making the SBR alternative more cost effective over the long term. Additional SBRs also offer continuity with the current secondary treatment process, which could simplify O&M and reduce labor costs.

Unlike the other alternatives, the Aero-Mod® system does not require pumps, only blowers. The blowers provide both aeration and suction lift for sludge removal and recirculation. This reduces the cost of maintenance and also reduces the size of building needed to house process equipment. However, the blowers consume a significant amount of energy compared with the other alternatives. A smaller equipment building would provide cost savings for the overall facility. The cost of an equipment building was not included in the probable capital cost for secondary treatment alternatives. The probable capital cost included process equipment, process structures, and installation.

The probable capital costs for the oxidation ditch and conventional activated sludge alternatives assumed a single secondary clarifier would be constructed. This reduces the reliability of these processes, since the secondary clarifier may occasionally be out of service for maintenance. Constructing an additional secondary clarifier would increase the probable capital cost.

Although the probable costs of a MBR are significantly higher than the other alternatives, there would be significant cost savings if effluent reuse were selected as a method of effluent disposal. A MBR would produce effluent of tertiary quality, thereby reducing the size of or eliminating the need for coagulation/filtration prior to disinfection. However, this cost savings would not offset the large differences in the probable capital and O&M costs.

5.3.2 Effluent Quality

Although all of the secondary treatment alternatives are capable of meeting the permit limits for BOD_5, TSS, and TN; some of the alternative treatment processes may be more difficult to control to produce effluent with consistent quality. The package-type Biolac® and Aero-Mod® systems operate differently than the conventional alternatives using internal recycle through aerobic/anoxic zones (i.e., MBR and conventional activated sludge) or phased aerobic/anoxic cycling (i.e., SBR and oxidation ditch) for oxidation and nitrification/denitrification of wastewater. The Biolac® "wave oxidation" creates moving "waves" of aerobic and anoxic zones by cycling the aeration chains on and off in a sequenced pattern. It is more difficult to control the HRT of wastewater in these anoxic and aerobic zones given that there is no distinct separation. This may create more variability in effluent quality. Similarly, the Aero-Mod® SEQUOX™ process is said to achieve denitrification in the second stage aeration basin during reaeration after oxygen has been depleted in the anoxic settling phase, rather than under complete mixed anoxic conditions as is generally practiced. This unconventional method of denitrification could also produce higher variability in effluent quality.

Effluent quality from the MBR process will far exceed the permit limits, particularly in terms of TSS removal. The MBR effluent will be capable of direct reuse, with proper disinfection. All other secondary treatment alternatives would require tertiary treatment (i.e., coagulation, flocculation, and filtration) to produce the same quality of effluent.

5.3.3 Expandability/Flexibility

The package-type plants, SBRs, and MBR are more easily expanded than oxidation ditches or conventional activated sludge. Package-type plants, SBRs, and MBR consist of a singular component or package that can be added in a modular fashion for additional capacity. Oxidation ditches and conventional activated sludge consists of multiple components and interconnecting piping and mechanical equipment making expansion and integration of new components more complex.

Because more conventional treatment processes (i.e., SBRs, oxidation ditch, conventional activated sludge, and MBR) allow easier control of effluent quality, these processes provide more flexibility with effluent quality limits to accommodate changing permit limits or effluent disposal methods, compared with package-type plants. However, the Aero-Mod® package-type plant offers a unique feature that allows the process to be isolated into smaller components so the process can be expanded as influent flow increases to avoid over aerating the wastewater for improved energy efficiency.

5.3.4 Treatment Efficiency

An oxidation ditch is a relatively efficient treatment process. Aeration and mixing are provided by rotors that are simple in design and operation and unlike diffusers, do not have plugging problems. Rotors are also a relatively efficient form of aeration because they have a high oxygen transfer rate per unit of energy.

SBRs are typically a more complex system to operate because of the sequenced batch operation. Jet aeration also tends to be energy intensive for smaller installations because both a blower and a mixing pump are operating simultaneously during the aerobic phase, where as most other aerobic processes achieve mixing with diffused aeration alone.

Conventional activated sludge is also an energy intensive process for this type of application. Diffused aeration is combined with internal recycle pumping and return activated sludge pumping to run the process. Because this process is not run as extended aeration, it is also susceptible to changes in biological activity and requires more monitoring.

Although the typical HRT of the MBR process is not characteristic of extended aeration, the SRT is and as a result more complex microorganisms necessary for nitrification/denitrification are allowed more than enough time to grow. The use of diffused air for aeration and membrane cleaning and the use of vacuum pumps to pull effluent through the membranes requires a significant amount of energy. However, the energy costs are offset somewhat by the absence of RAS pumping.

Energy consumption of the package-type plants is comparable to the oxidation ditch process. Both require aeration and RAS pumping, although the package-type plants use diffused aeration, rather than mechanical aeration. The Aero-Mod® system uses ball valves along the distribution piping to control air flow, which have limited precision. A variable frequency drive on the blowers would provide better flow control. In addition, the Aero-Mod® system should include a mechanism for scum removal, since the standard clarifier does not include an outlet for scum. The Biolac® process often operates at a SRT of 50 days, which significantly reduces the quantity of sludge produced and in some cases supplants the need for separate sludge stabilization.

5.3.5 Land Requirement

Because the MBR process has a low HRT and eliminates separate clarification by using submerged membranes, it would require the least amount of space for tanks and equipment. The SBR process would require a larger tank than the MBR process, but because it too does not require separate clarification, it would require less space than the remaining alternatives. The Aero-Mod® package-type plant would require slightly more space than an SBR because of the two stages of aeration basins and separate tank for clarification. However, because of common wall construction, the Aero-Mod® package-type plant uses space efficiently. Conventional activated sludge would require less space than an oxidation ditch, since the HRT and associated tank volume is less for conventional activated sludge. However, both alternatives require a substantial amount of space because each utilizes separate tanks for biological treatment and clarification. The Biolac® package-type plant would require the most space since it is constructed in a large earthen lagoon and also includes a separate clarification structure.

5.3.6 Aesthetics

An MBR would have a minimal impact on aesthetics since it would be relatively small in size. An SBR would have a slightly greater visual impact due to its larger size. Similarly, the Biolac® package-type plant would have a greater impact on aesthetics since the lagoon is very large, although it is an earthen structure constructed below grade. The conventional activated sludge, oxidation ditch, and Aero-Mod® system would have the greatest impact on aesthetics since each of those alternatives involves multiple concrete tanks of substantial size, although common wall construction with the Aero-Mod® system would help mitigate the impact.

5.3.7 Odor Concerns

Odor should not be a significant problem for any of the secondary treatment alternatives. Properly mixed and aerated wastewater will produce minimal odors. However, some amount of odors will be present and that amount will increase in relation to the area of exposed wastewater surface. The Biolac package-type plant would have the greatest area of exposed wastewater surface, which creates the greatest opportunity for odors to transfer into the air. Conversely, the MBR process would have the least amount of area of exposed wastewater, which would limit the transfer of odors into the air. For the remaining alternatives, the potential for odors is assumed to be in direct relation to the exposed wastewater surface area, as suggested by their use of space.

Section 6: Effluent Disposal Alternatives

6.1 Effluent Disposal

The effluent from the Cold Springs Wastewater Treatment Facility is currently disposed of by land application to RIBs. The effluent is allowed to percolate in an effort to recharge the aquifer. When determining an appropriate effluent disposal method, the long-term health and sustainability of the aquifer is the overwhelming priority. Thus, any disposal option that involved the export of effluent from the closed basin was rejected as infeasible.

6.1.1 Surface discharge

The potential to discharge effluent to White Lake was initially considered but rejected as an unacceptable alternative because of the detrimental impact on the aquifer. The large majority of any discharge to the playa would evaporate and be lost from the basin. This would result in the continuous depletion of the groundwater, eventually impacting the aquifer. Additionally, any surface discharge would require the effluent to be treated to a higher standard than it currently is, resulting in treatment cost increases. The only advantage to discharging to the playa is the elimination of particulate air pollution that is typically lifted from the surface during periods of high winds.

6.1.2 Land Application to RIBs

Land application to rapid infiltration basins is the current effluent discharge strategy for the Cold Springs Wastewater Treatment Facility. There are approximately 8 acres of RIBs for the rated 0.35 MGD facility. To accommodate the increased flow from new development an additional 10 acres of RIB will be needed assuming the existing RIBs are properly sized considering such factors as infiltration and percolation rates. The existing RIBs have not seen enough flow to determine if their performance compares favorably to the original design criteria. The site of the Cold Springs Wastewater Treatment Facility is placed such that the additional required land is available adjacent to the plant.

6.1.3 Land Application with Re-Use

This option has some of the treatment plant effluent being used to irrigate common space vegetation such as parks and greenbelts. Because the majority of effluent applied as irrigation water will be absorbed by the plants and ultimately lost from the basin via evapo-transpiration, the amount of effluent used for irrigation will be determined by the long-term health of the aquifer. The reuse of some of the effluent will require the construction of a distribution system from the treatment plant to the reuse site. This system will require an effluent pump station at the treatment plant and reuse piping to the reuse site. The cost of the system will depend on the distance from the treatment plant to the reuse site and the amount of street trenching required.

6.2 Groundwater Analysis

A hydrogeological/groundwater titled *Ground-Water Flow and Solute Transport Model, North Cold Spring Valley*, was conducted by Broadbent and Associates Inc. as part of the wastewater facility planning study. The model determined that excessive groundwater mounding would occur if all of the effluent was applied to RIBs at the treatment plant site. By the year 2020 the groundwater in the vicinity of the treatment plant would rise to an elevation of approximately 5,065 feet, 15 feet below ground level. The groundwater would continue to rise beyond this date as more effluent is applied to the RIBs. Thus it was determined that some portion of the effluent be reused as irrigation water. Broadbent ran the model to determine the amount of effluent that must be reused in order to hold the groundwater at a constant 5, 10, and 15 feet below ground surface at the RIBs. Because the model assumed a linear increase in wastewater flow from present until design flow is reached, no reuse of effluent was contemplated until flows were sufficiently large to require it. This occurs in the year 2017 for the least conservative option (15 feet) and 2022 for the other two options. Prior to these dates the full amount of effluent is needed for recharge to minimize the impact on the overall water balance in the basin. The available reuse volumes for the three options are given in Table 12.

Table 12

Effluent Available for Irrigation

Depth to Groundwater at Treatment Plant (ft)	Year Irrigation Water Becomes Available	CSWWTP Flow (MGD)	Amount Available (gal/day)
5	2022	0.41	35,000
10	2022	0.41	50,000
15	2017	0.30	55,000

6.3 Conclusion

The groundwater analysis indicated that at design flow a portion of the effluent must be reused in order to protect the treatment plant from groundwater mounding. Because the excessive flows are not expected for several years, the discharge strategy will be to apply all of the effluent to the RIB in an effort to recharge the aquifer until the groundwater level in the monitoring wells rise sufficiently to cause concern. At that time the overall water balance in the basin should be addressed to determine the volume of effluent that must be reused and where the reuse should take place. This evaluation should occur early enough to allow Washoe County to build the necessary infrastructure for the effluent reuse operation.

Ultimately the timing of the construction of new RIB and the use of effluent for irrigation depends on treatment plant flows. If the actual growth rate, and thus the increase in treatment plant flow, is faster than projected, effluent for irrigation may be available sooner than projected. Likewise, if growth is slower than projected, effluent available for irrigation may be delayed.

The groundwater analysis was conducted assuming a maximum month average daily flow of 325 gpd/ERU which is 25 gpd below the Washoe County design standard. Even with this reduction it is expected that the actual flow will be lower than the calculated flow used in the groundwater model. Thus it is possible that no effluent will be available for reuse throughout the service life of the treatment plant. Because of this it is recommended that Washoe County delay the design of any effluent distribution system or plans for any sites that would depend on effluent for irrigation until a more accurate flow projection can be made.

Section 7: Wastewater Treatment Plant Expansion Recommendations and Preliminary Design

7.1 Summary of Recommendations

The following paragraphs provide a brief summary of the reasons each process alternative was chosen for expansion and upgrade of the CSWWTP. Refer to Figure 3 for a process schematic of the recommended improvements. The process expansion recommendations are:

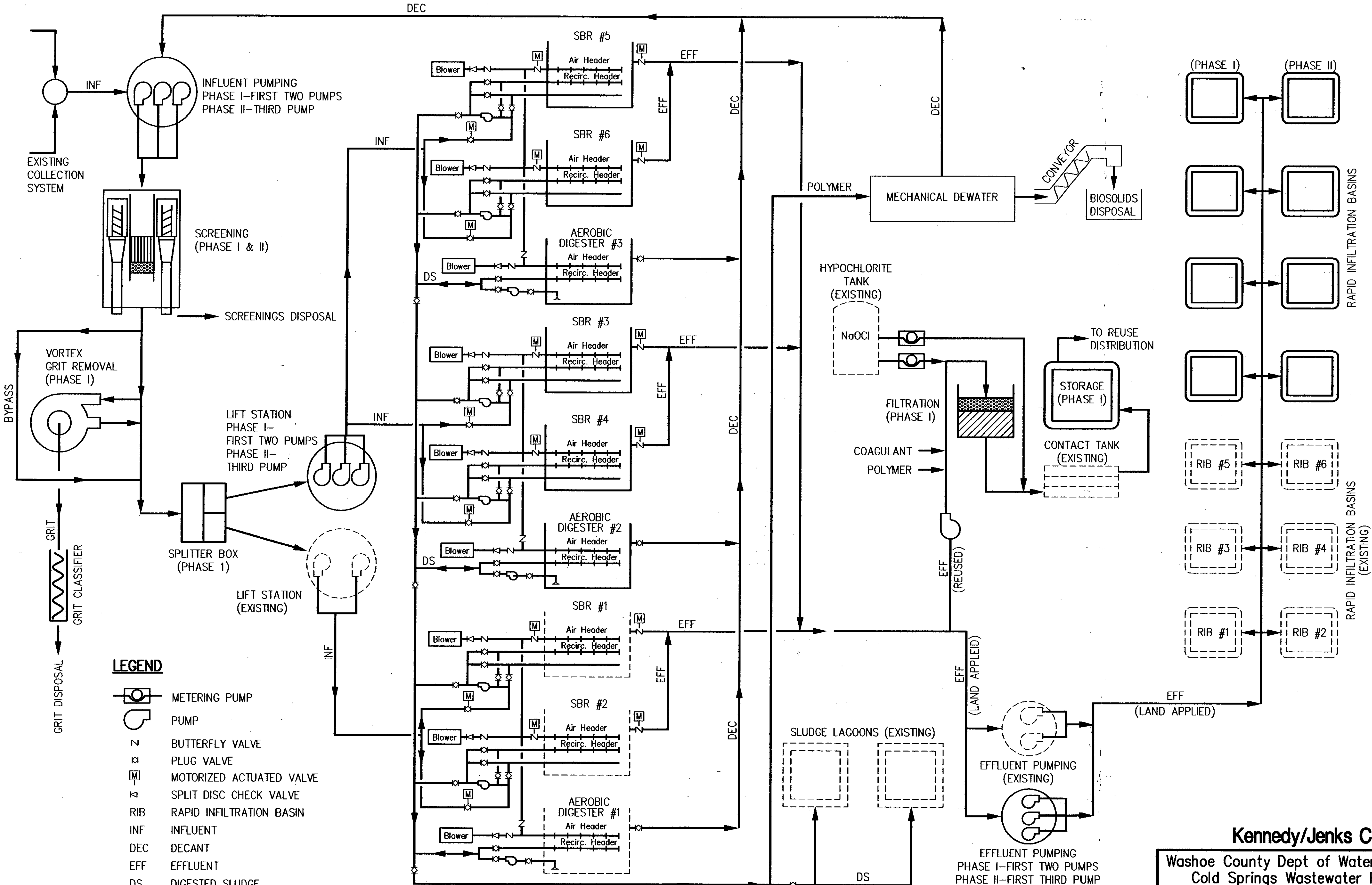
- Screening – Perforated Basket.
- Grit Removal – Vortex.
- Secondary Treatment – Additional SBRs.
- Disinfection – Chorine for reused effluent and UV if future regulatory requirements are put in place for land applied effluent.
- Filtration – for reuse water.
- Sludge Stabilization – Aerobic Digestion.
- Sludge Dewatering – Mechanical Dewatering.

7.1.1 Screening

A perforated basket screen is recommended not only because it is the least expensive alternative, but also because it combines screening, washing, and compaction in a single unit. The washing and compaction zones are completely enclosed, which minimizes the release of odors.

7.1.2 Grit Removal

Vortex grit removal is the recommended alternative. This is the most expensive alternative however the benefits of reliable operation and ease of maintenance warrant the extra expenditure. Horizontal-flow channels are the least expensive alternative for grit removal. For relatively small installations, such as the CSWWTP, horizontal-flow channels are typically free of mechanical equipment. This results in very low capital and maintenance costs. Larger installations often use mechanical chain and flights and screw augers to collect and remove grit. Because settled grit in a horizontal-flow channel must be removed manually, it can be more labor intensive to operate. Grit is manually shoveled or scooped out of the channels once or twice a month. Because settled grit may remain in the channels for weeks at a time, odors may be released if conditions within the settled grit become anaerobic. The grit removal from the channels is a messy and labor intensive operation and is likely to be ignored. Because of the operation and maintenance considerations, horizontal-flow channels are not recommended and should only be considered for implementation as a low cost substitute for the preferred vortex grit removal.



LEGEND

- METERING PUMP
- PUMP
- BUTTERFLY VALVE
- PLUG VALVE
- MOTORIZED ACTUATED VALVE
- SPLIT DISC CHECK VALVE

RIB	RAPID INFILTRATION BASIN
INF	INFLUENT
DEC	DECANT
EFF	EFFLUENT
DS	DIGESTED SLUDGE
MGD	MILLION GALLONS A DAY

PHASE 1 – 450 MGD EXPANSION FOR FUTURE DEVELOPMENT

PHASE 2 – 450 MGD FOR POSSIBLE SEPTIC SYSTEM CONVERSION

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

Cold Springs Wastewater Treatment Plant
Process Schematic of
Recommended Alternative

K/J 007018.01
July 2002

Figure 3

P:\007018.01\Facility-Plan-Addendum\Schematic-1.dwg

7.1.3 Secondary Treatment

Additional SBRs are recommended for secondary treatment based primarily on being the least cost alternative, using space efficiently, and maintaining continuity with the existing treatment plant. All of the alternatives evaluated are capable of meeting or exceeding the effluent discharge requirements, are capable of expansion in a modular fashion, and do not present a significant odor concern. Because the operators are already familiar with and will continue operating the existing SBRs, expanding the treatment plant with additional SBRs will avoid the complexity of operating two different secondary treatment processes.

7.1.4 Disinfection

The current discharge permit for the CSWWTP does not require disinfection of land applied effluent. It is recommended that the existing disinfection process (chlorination) be used to disinfect the portion of effluent to be reused in irrigation. If discharge permit requirements change to require the disinfection of land applied effluent it is recommended that UV be the method of disinfecting the effluent to be land applied and the existing chlorine system be used to disinfect the effluent to be reused. Although chlorine disinfection is slightly less expensive than UV disinfection over a 20-year life cycle, UV disinfection is recommended if regulatory requirements are imposed by the NDEP. UV disinfection has a moderate O&M cost, which will make it's present worth lower than chlorine disinfection just a couple of years beyond the 20-year life cycle. Furthermore, UV disinfection uses less space and eliminates the need to store and handle hazardous chemicals.

7.1.5 Filtration

Granular-media filters are employed to remove suspended solids from the treated effluent. The filtration process is either plain or traditional. In plain filtration, the effluent from the secondary treatment process is applied directly to granular-media filters. Plain filtration can reduce TSS to 10 mg/l, however small particles including microorganisms pass through the media. Traditional filtration, which includes coagulation/flocculation, is more commonly used and can reduce TSS concentration below 5 mg/l. Filter cells can be either gravity or pressure filters. Gravity filters have a deeper filter box and are usually cheaper because flow controllers are eliminated. The preferred filter media are coal-sand dual media or mixed media containing anthracite coal, garnet, and sand. Multimedia beds allow greater solids holding capacity, resulting in longer filter runs. Efficient backwashing and auxiliary air scrubbing or a rotating agitator provides adequate cleaning and improves scouring action. Chlorination prior to filtration prevents growth within the filter.

The filtration system must either be sized to process diurnal peak flows or include a flow equalization tank. Flow equalization is generally more cost-effective because of the number of treatment units in sequence. Wastewater plants using flow equalization tanks provide more reliable treatment and disinfection by attenuating flow variability, which also allows shorter contact times.

The total filter area is designed for the peak design flow with one unit out of service for backwashing or repair. Typical design flow rates are 3 to 5 gpm/sf, with a minimum 24 hours between backwashes under normal design conditions.

7.1.6 Sludge Stabilization

Aerobic digestion is recommended for sludge stabilization based on being the least cost alternative. Because sludge from the CSWWTP is currently being disposed of at the Lockwood Regional Landfill, there is no benefit to using ATAD at a higher cost to produce Class A biosolids. Producing Class A biosolids is only an advantage when there are few land application sites available that accept Class B biosolids. The energy savings with anaerobic digestion are not large enough to overcome the high capital cost for a small installation such as this. Larger installations receive a significant benefit.

7.1.7 Sludge Dewatering

Mechanical dewatering using centrifuge or belt filter press equipment is the recommended alternative for sludge dewatering. Although this process has the highest present worth cost the other sludge dewatering alternatives have odor control concerns. Given the close proximity of future development the added cost is warranted to prevent odor issues and complaints. Filter block beds are recommended as a lower cost alternative for sludge dewatering based on the suitable environment, high solids content in the dried sludge, and less potential for odors compared with sludge lagoons. Sludge lagoons are less expensive, but the lagoons have a higher potential for odors and lower solids content in the dried sludge compared with sludge drying beds. A lower solids content increases the amount of water, and thus the volume of sludge to be disposed.

7.1.8 Rapid Infiltration Basins

Additional RIBs adjacent to the existing RIBs are recommended for the continued effluent disposal. As discussed in Section 6 approximately 10 acres is estimated for plant expansion to 0.80 MGD.

7.2 Preliminary Cost Estimate

Table 13 provides an estimate of the capital and O&M costs for the recommended initial treatment plant expansion to a capacity of 0.80 MGD. Because this expansion phase for the treatment plant is for future residential development it will be funded by developers.

Table 13

Preliminary Cost Estimate

Process	.45 MGD Expansion ($)
Influent Lift Station	
Earthwork	35,000
Structure	60,000
Equipment	12,000
Installation	20,000
Screening	
Earthwork	5,000
Structure	34,000

Table 13 Preliminary Cost Estimate	
Process	**.45 MGD Expansion ($)**
Equipment	45,000
Installation	6,000
Vortex Grit Removal	
Earthwork	2,000
Structure	7,000
Equipment	79,000
Installation	20,000
Intermediate Lift Station	
Earthwork	24,000
Structure	35,000
Equipment	12,000
Installation	15,000
Splitter Box	
Earthwork	3,000
Structure	9,000
Equipment/Installation	6,000
Sequencing Batch Reactors	
Earthwork	50,000
Structure	340,000
Equipment	275,000
Installation	100,000
Effluent Pumping	
Earthwork	24,000
Structure	35,000
Equipment	12,000
Installation	15,000
Rapid Infiltration Basins	
Earthwork	250,000
Structure	15,000
Aerobic Digestion	
Earthwork	20,000
Structure	115,000
Equipment	135,000
Installation	50,000
Sludge Dewatering	
Equipment	232,000
Installation	115,000
Equipment Building	
Earthwork	21,000
Structure	257,000
Emergency Generator	
Equipment	100,000
Installation	50,000

Table 13 Preliminary Cost Estimate	
Process	**.45 MGD Expansion ($)**
Treatment/Storage for Effluent Reuse	
Coagulation	45,000
Filtration	215,000
Disinfection Improvements	30,000
Storage	150,000
Fencing and Surfacing	18,000
Site Work	5,000
Yard Piping (10%)	284,000
Electrical (12.5%)	55,000
Instrumentation (5%)	142,000
Contractor Overhead/Profit (20%)	568,000
Construction Subtotal	**4,452,000**
Contingency (15%)	667,800
Construction Cost	**5,119,800**
Taxes (7.25%)	384,000
Total Construction Cost	**5,503,800**
Design, Construction Mgmt., Permits, and Legal (25%)	1,376,000
Total Project Cost	**6,879,800**

7.3 Other Considerations

In planning the expansion and upgrade of an existing facility, there are items other than selection of treatment processes that must be considered. The expansion and upgrade of support facilities (e.g., emergency generator, laboratory/office space, equipment buildings) and related work must be considered for a fully functional facility. In addition, the design criteria and rating of the existing plant should be reevaluated for consistency with design criteria for the expansion and upgrade and with the existing operating conditions, which may not be consistent with the original design assumptions.

7.3.1 Support Facilities

The following support facilities and related work are necessary to integrate expansion and upgrade components into a fully functional facility:

- Influent/Effluent Pumping
- Emergency Generator
- Laboratory/Office Space
- Equipment Buildings
- Sitework

- Paving and Fencing
- Yard Piping
- Electrical/Instrumentation
- Odor Control

7.3.1.1 Influent/Effluent Pumping

Based upon the hydraulic grade between the influent sewer and the existing SBRs and the recommendation of adding screening and grit removal, influent pumping will be required from the screening and grit removal processes to the SBRs, as well as from the influent sewer to the screening and grit removal processes. It is recommended that influent flow be pumped from a single lift station to the screening channel. Wastewater will flow by gravity through the screening and grit removal processes to a splitter box. The splitter box will divide the flow among two separate lift stations, one of which is the existing influent lift station. The existing influent lift station will pump screened and degritted wastewater to the existing SBRs. A second new lift station will pump screened and degritted wastewater to the new SBRs. Refer to Figure 4 for a process schematic of the improvements described.

The existing effluent pumping capacity needs to be expanded to maintain sufficient capacity to handle the projected peak hour flow. The existing effluent pump station has a capacity of approximately 1.5 MGD. Additional pumping capacity can be obtained by installing a second effluent pump station and/or replacing the existing pumps with higher capacity pumps. In addition, a separate pump station must be installed to deliver effluent treated for reuse to temporary storage prior to distribution.

7.3.1.2 Emergency Generator

The existing emergency generator is undersized to provide power to critical components of an expanded and upgraded CSWWTP. Therefore, the existing emergency generator may need to be replaced, or a second generator added.

7.3.1.3 Laboratory/Office Space

The existing office and laboratory should be evaluated to determine the need, if any, for additional space to accommodate an expanded facility and possibly additional staff.

7.3.1.4 Equipment Buildings

Additional building space will be required to house equipment associated with the plant expansion.

7.3.1.5 Sitework

This item includes general site clearing, grubbing, rock removal, grading, and excavation in preparation for construction.

7.3.1.6 Paving and Fencing

The extent of paving and fenced area will need to be expanded to accommodate the larger expanded facility.

7.1.3 Secondary Treatment

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- Yard Piping
- Electrical/Instrumentation
- Odor Control

7.3.1.1 Influent/Effluent Pumping

Based upon the hydraulic grade between the influent sewer and the existing SBRs and the recommendation of adding screening and grit removal, influent pumping will be required from the screening and grit removal processes to the SBRs, as well as from the influent sewer to the screening and grit removal processes. It is recommended that influent flow be pumped from a single lift station to the screening channel. Wastewater will flow by gravity through the screening and grit removal processes to a splitter box. The splitter box will divide the flow among two separate lift stations, one of which is the existing influent lift station. The existing influent lift station will pump screened and degritted wastewater to the existing SBRs. A second new lift station will pump screened and degritted wastewater to the new SBRs. Refer to Figure 4 for a process schematic of the improvements described.

The existing effluent pumping capacity needs to be expanded to maintain sufficient capacity to handle the projected peak hour flow. The existing effluent pump station has a capacity of approximately 1.5 MGD. Additional pumping capacity can be obtained by installing a second effluent pump station and/or replacing the existing pumps with higher capacity pumps. In addition, a separate pump station must be installed to deliver effluent treated for reuse to temporary storage prior to distribution.

7.3.1.2 Emergency Generator

The existing emergency generator is undersized to provide power to critical components of an expanded and upgraded CSWWTP. Therefore, the existing emergency generator may need to be replaced, or a second generator added.

7.3.1.3 Laboratory/Office Space

The existing office and laboratory should be evaluated to determine the need, if any, for additional space to accommodate an expanded facility and possibly additional staff.

7.3.1.4 Equipment Buildings

Additional building space will be required to house equipment associated with the plant expansion.

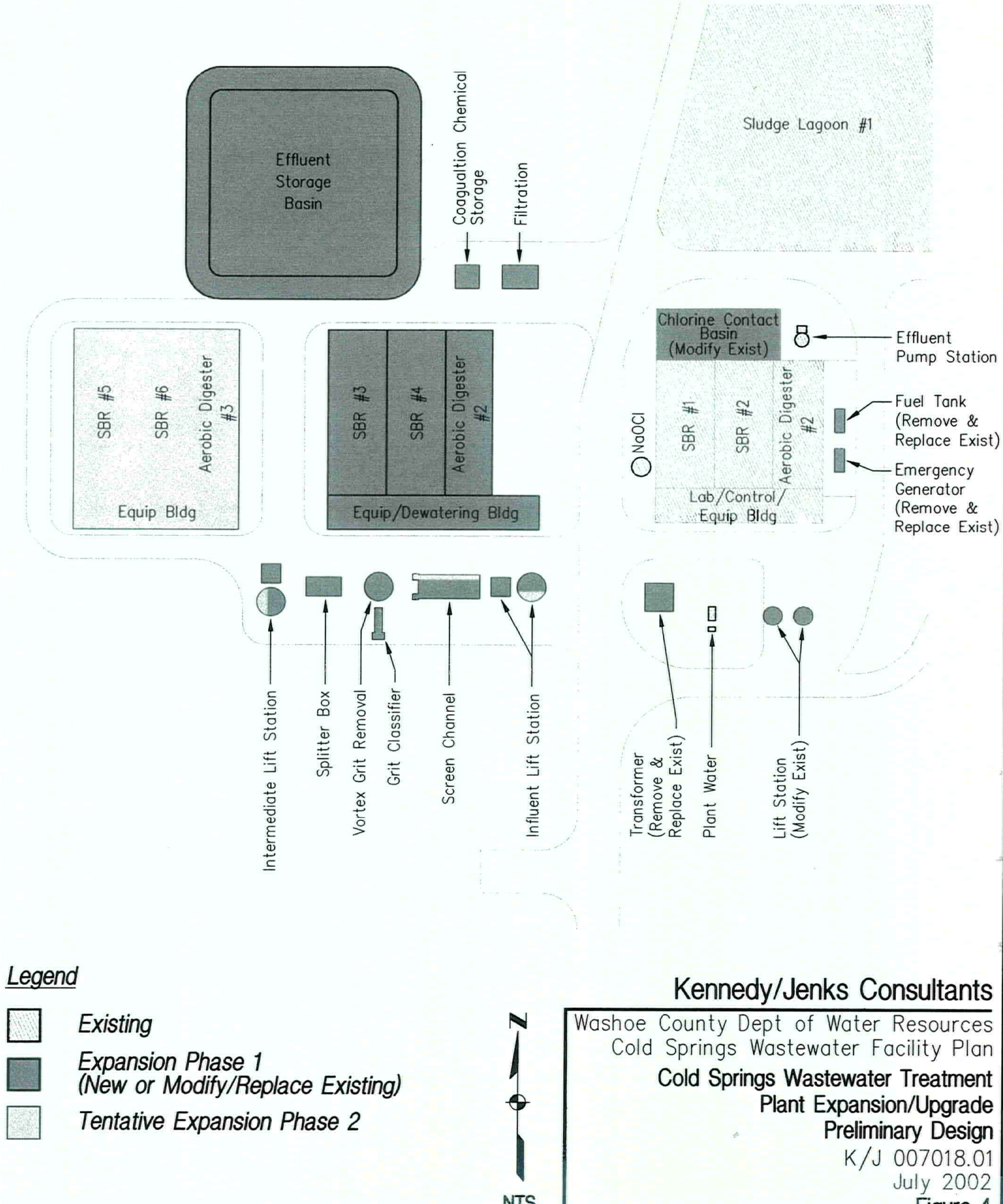
7.3.1.5 Sitework

This item includes general site clearing, grubbing, rock removal, grading, and excavation in preparation for construction.

7.3.1.6 Paving and Fencing

The extent of paving and fenced area will need to be expanded to accommodate the larger expanded facility.

Cold Springs Wastewater Facility Plan



Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

Cold Springs Wastewater Treatment Plant Expansion/Upgrade Preliminary Design

K/J 007018.01
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Figure 4

7.3.1.7 Yard Piping

Additional yard piping will be required to convey wastewater and sludge between the treatment processes added for expansion.

7.3.1.8 Electrical/Instrumentation

Expansion of the treatment plant will require additional electrical and instrumentation components to supply power to the new equipment and monitor process operations.

7.3.1.9 Odor Control

Contingent upon the process alternatives selected plant expansion may require some odor control features. An air quality permit will determine if best available control technology will be required or not.

7.3.2 Treatment Plant Expansion Implementation

As mentioned previously, the measured influent concentration of BOD_5 is significantly higher than the design criteria of 200 mg/l BOD_5 used for the existing CSWWTP or the 220 mg/L used in this facility planning. This is very likely due to a lower than expected average flow from individual residences compared to the Washoe County average annual flow design standard of 350 gpd. The existing plant is designed for a flow of 350,000 gpd, or 1,000 residences at 350 gpd each. A lower volume of flow from each residence would result in a higher concentration of waste, assuming the waste load associated is consistent with medium-strength municipal wastewater. The fact that the wastewater collection system is just a few years old and the climate is generally dry would contribute to a lower average flow per residence. A new collection system would be very tight essentially eliminating infiltration and inflow, which contributes to the volume of flow and dilutes the strength of the wastewater. Additionally, the absence of significant precipitation much of the year further reduces the amount of infiltration and inflow. The collection system to be constructed as part of the Lifestyle/Woodland development which provides the majority of the flow to the expanded treatment plant is above the water table.

Because the volume of flow per residence is likely lower than anticipated, the number of residences that can be connected to the existing treatment plant may be impacted. Furthermore, the original design criteria (e.g., HRT, SRT, concentration of mixed liquor suspended solids, etc.) should be revisited based on knowledge of actual wastewater characteristics. Characterization of the wastewater could lead to changes in the original design criteria to optimize treatment, which may also impact overall treatment capacity.

Critical design criteria are the specific denitrification rates that determine the length of time required for anoxic conditions in the SBRs, nitrification kinetics that determine the required SRT for activated sludge in the SBRs, and solids yields that determine the concentration of mixed liquor required to meet the SRT. These critical design criteria can be more accurately derived from characteristics of the wastewater, rather than using typical values. Utilizing design criteria based upon actual conditions will improve operations of the plant and maximize use of available capacity. It is recommended that the plant influent be sampled more frequently to provide sufficient data to characterize the wastewater. It is suggested that 24-hour weighted composite samples be collected every day during a warm weather month and again during a cold weather month. Additional samples should be collected 2 or 3 times a week for 3 additional months and tests completed to analyze the following constituents:

- BOD_5
- TSS
- Total Kjeldhal Nitrogen (TKN)
- Alkalinity
- pH
- Temperature

Kennedy/Jenks considered evaluating the capacity of the SBRs based on the original design criteria and existing data available for influent wastewater characteristics. The manufacturer of the SBR equipment was contacted for input and comments on this evaluation. After discussing this idea with the SBR equipment manufacturer and reviewing the limited data available, Kennedy/Jenks concluded that it is unlikely any significant change in the capacity of the existing SBRs would be realized by completing this exercise. Kennedy/Jenks recommends waiting about one year after additional data has been compiled for wastewater characterization and the influent wastewater has been monitored for significant changes in flow, concentration of BOD_5 and TSS, and waste load. Influent characteristics may change as more residences begin to contribute wastewater. Consequently, the original design criteria may not be suited to the actual application. At that time, sufficient information will be available for a more accurate analysis utilizing confirmed design criteria allowing for accurate sizing of facilities and equipment during the detailed design.

Section 8: Environmental Review

The proposed project is an expansion of the existing Cold Springs wastewater treatment plant. The existing treatment facility utilizes twin sequencing batch reactors and is rated at 0.35 MGD. Potential growth in the Cold Springs basin requires the expansion of the plant to meet projected flows. The selected alternative for the initial wastewater treatment plant expansion is additional SBRs to increase rated capacity to 0.80 MGD with the majority of effluent disposal using RIBs and a portion of the effluent filtered and disinfected with chlorine and reused in irrigation.

8.1 Physical Aspects

The Cold Springs Wastewater Treatment Plant is located at the Eastern base of the Petersen Mountains approximately 2 miles north of White Lake in the Cold Springs basin (T 21 N, R 18 E, SW ¼ SW ¼ Sec 9, MDB&M). The plant is located on silty clay loam soil (SCS# 1160) with a slope less than 1%. The groundwater is approximately 40 ft below ground surface at the treatment plant site. There are no limiting physical conditions in the planning area. No evidence of slides from the Petersen Mountains is visible and the seismic hazard is minimal (PGA for 2%-50 year event is 0.62g). There are no unusual or unique geological features that might be affected by the treatment plant expansion.

8.2 Climate

The service area has a cool, semi-arid continental climate characterized by warm summers and mild winters. The area receives approximately 12 inches of precipitation annually and experiences about 5 feet of evaporation. The average high temperatures for the region are: summer, 85 F, winter, 42 F. Average lows are: summer, 52 F and winter, 18 F. There are no unusual or special meteorological conditions that may result in an air quality problem or affect the feasibility of the proposed treatment plant expansion.

8.3 Population

The current population of the Cold Springs basin is estimated to be 3600, of which only about 1442 are served by the wastewater treatment plant. The remainder use on-site wastewater disposal systems, typically conventional septic tanks. When the Woodland Village tentative map development is complete, expected in 2008, the wastewater treatment plant will be serving approximately 8,500 residents and the basin population will be approximately 12,000. This amount is equivalent to an annualized growth rate of 21%. While this is high, the growth rate is expected to fall to near zero after the Woodland Village tentative map development is complete. The current wastewater treatment plant expansion is intended only for development already approved by Washoe County, thus it is not expected to promote further growth in the Cold Springs basin.

8.4 Housing, Industrial and Commercial Development and Utilities

The proposed expansion of the treatment plant will not displace any existing homes or businesses. The land intended to be used for the expansion is currently owned by Washoe County and is undeveloped. The expansion will not affect any environmentally sensitive area or be in or create any special hazard or danger zones. The new homes to be served by the treatment plant expansion will necessarily affect the transportation patterns in the basin as well as utilities and services. It is assumed that these impacts were considered by Washoe County prior to approving the development and determined to be insignificant.

8.5 Economic and Social Profile

The initial expansion project will be funded by the developer with the individual homeowner's portion being included in the cost of the home. No cost will be borne by the existing residents of the basin. Additionally, the expansion is not expected to adversely affect land value in the area.

8.6 Land Use

The project will not affect the currently inhabited areas of the basin. Because it will be constructed on land that is undeveloped, it will not displace any historic land use or cause the land use to change.

8.7 Floodplain Development

The existing treatment plant and the proposed expansion sit above the 100-year flood plain. All of the proposed development to be served by the treatment plant expansion is also above the 100-year flood plain.

8.8 Wetlands

There are no wetlands at or near the project site or in the area to be served by the project.

8.9 Wild and Scenic Rivers

The planning area does not have any rivers that are designated or are proposed to be designated as wild and scenic rivers.

8.10 Cultural Resources

The wastewater treatment plan site is not listed or eligible to be listed on the National List of Historic Places. Cultural resources have been found in the nearby Woodland Village subdivision and have been mapped and addressed to the satisfaction of the State Cultural Resources office.

8.11 Flora and Fauna

The planning area does not have any threatened or endangered species. The native flora and fauna will feel no significant impact. No designated sensitive habitat areas are located within the planning area.

8.12 Recreation and Open Space

The project will not eliminate or modify any recreational open space or any area recognized as scenic. The planning area will contain several parks, walking paths and bicycle paths for residents and visitors.

8.13 Agricultural Lands

The planning area does not contain any agricultural land of any kind.

8.14 Air Quality

All emissions from the proposed treatment plant expansion are within the State Implementation Plan (SIP) standards for Washoe County. The population projections for the area were obtained from Washoe County Community Development, and the RTC which is where the projections for this study were obtained. Washoe County Air Quality Management Division states that the proposed project conforms to the SIP for Washoe County and that there will not be a conflict with any SIP in Sierra or Lassen County, CA. The proposed project does not violate any national ambient air quality standard. AQMD stated that a properly operating treatment plant would not produce any odors that would be considered a nuisance.

8.15 Water Quality

The discharge from the treatment plant will be used to recharge groundwater via rapid infiltration basins, thus the effluent will not impact surface water. The plant design criteria is based on NDEP permit requirements for infiltration to groundwater. The development to be served by the wastewater treatment plant expansion will cause some runoff concerns. It is assumed that these were addressed by Washoe County during the review process for the new development. The water purveyor for Cold Springs, Utilities Inc. of Nevada, has indicated a willingness to serve the new development of the entire tentative map. Utilities Inc. indicates that they hold sufficient water rights to serve the development. The wastewater treatment plant expansion will not affect the water rights held by Utilities Inc. The project will result in the majority of the wastewater being returned to the groundwater after treatment. The infiltration of the treatment plant effluent will aid in ensuring the long-term viability of the aquifer.

8.16 Public Health

The noise from the treatment plant expansion is not expected to be any greater than the current treatment plant operations. The increased flow will require additional RIBs, which may create a vector problem. Proper vector control has served to limit the impact from the existing RIBs and it is expected that the same techniques will be employed for the expansion. The proposed expansion will not create any threats to public health in the basin.

8.17 Land Application

The treatment and disposal techniques selected are proven technology that is currently being used at the existing treatment plant. There is some public controversy over the expansion of the treatment plant, but none of it questions the treatment techniques selected. The controversy is over the actual development of the basin, which has already been approved by Washoe County. The new development to be served by the treatment plant expansion will require additional water rights which the water purveyor, Utilities Inc. of Nevada, has indicated have already been acquired.

8.18 Regionalization

There are no jurisdictional disputes over the project. This project does involve the expansion of a small treatment plant but the exportation of water from the Cold Springs basin would have a significant impact on the long-term viability of the aquifer. Thus, transporting the water to the Reno-Stead Wastewater Treatment Facility for treatment was not considered a viable alternative. No inter-jurisdictional agreements have been signed with respect to this project.

8.19 Public Participation

The controversy associated with the project is directed at the development of the Cold Springs basin, which has already been approved by Washoe County. No controversy is directed at the expansion of the treatment plant directly. The Wastewater Facility Study was conducted in conjunction with a Citizens Wastewater Committee. The committee met monthly with representatives from Kennedy/Jenks Consultants to discuss and seek public input regarding the wastewater treatment plant expansion. The committee reported to the Citizens Advisory Board (CAB) at their monthly meetings. Representatives from Kennedy/Jenks and Washoe County Utilities also attended the CAB meeting to answer questions and present summaries of the facility planning.

Section 9: Conclusion

The initial expansion of the Cold Springs Wastewater Treatment Facility to 0.8 MGD should be completed on the existing plant site using an expansion of the existing treatment technology to meet the near term needs of new development. This technology is proven to be capable of treating the wastewater to the discharge standard and is familiar to the wastewater treatment operators. This expansion will minimize the impacts to the community as well as the treatment plant staff and allow the facility to meet the demands of a growing community.

A second expansion of the plant of an additional 0.45 MGD to provide a total treatment capacity of 1.25 MGD is contingent upon growth rate, the total growth realized and also conversion of the existing residences using septic systems. These subjects are discussed in greater detail in Part Two of this facility plan. Additional growth above and beyond the limits of the facility plan and the conversion of existing septic systems outside of the facility plan limits may result in a required treatment capacity greater than 1.25 MGD.

Part Two of this facility plan addresses conversion of the existing septic systems within the facility plan limits and its impact on the size of Phase Two of the plant expansion.

References

Broadbent & Associates, (2001). Ground-Water Flow and Solute Transport Model, North Cold Springs Valley, Washoe County, Nevada.

Gunderson Associates Ltd. (1999). Technical Memorandum – Bordertown Expansion Wastewater Treatment Cost Options.

Metcalf & Eddy, (1979) Wastewater Engineering –Treatment, Disposal, Reuse. McGraw – Hill, Boston, MA.

Nimbus Engineering (1999). Technical Memorandum – Cold Springs Valley Groundwater Investigation

Washoe County Utility Services Division (2000). Technical Memorandum – Sun Valley Projected Sewer Flows.

Table of Contents – Part Two

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Appendix

Section 1: Introduction

1.1 Cold Springs Wastewater Facility Planning

Part Two of this wastewater facility plan pertains to existing septic systems in use in Cold Springs with the wastewater facility planning limits and the connection of Bordertown improvements to the community sewer system. Part One of the facility plan addresses the expansion of the existing Cold Springs Wastewater Treatment Plant (CSWWTP). The CSWWTP requires expansion to serve future residential and commercial development. CSWWTP expansion may also be required for serving the possible conversion of existing areas utilizing standard septic tanks and leach fields for wastewater treatment and disposal.

Wastewater facility planning in Cold Springs was first needed to address planned residential development by Lifestyle/Woodland Homes. The Washoe County Department of Water Resources was aware that groundwater nitrate concentrations in portions of the Cold Springs Valley exceed State of Nevada maximum concentrations and considered including in the wastewater facility planning the existing developed areas using septic tanks with leach fields as wastewater treatment and disposal systems. Washoe County surveyed area landowners regarding their desire to be included in the wastewater facility planning process. The wastewater facility planning limits were established based on landowner responses. Refer to Figure 1 for the Cold Springs wastewater facility planning study limits. It should be noted that in the area east of the proposed Bordertown residential development the majority of the landowners surveyed requested to not be included in the facility plan. This area utilizes standard septic tank and leach field disposal systems and each lot has its own domestic well for drinking water supply. The wastewater facility planning area includes the Bordertown commercial area and their proposed residential development as requested by the owner.

1.2 Project Description

Part Two addresses the following.

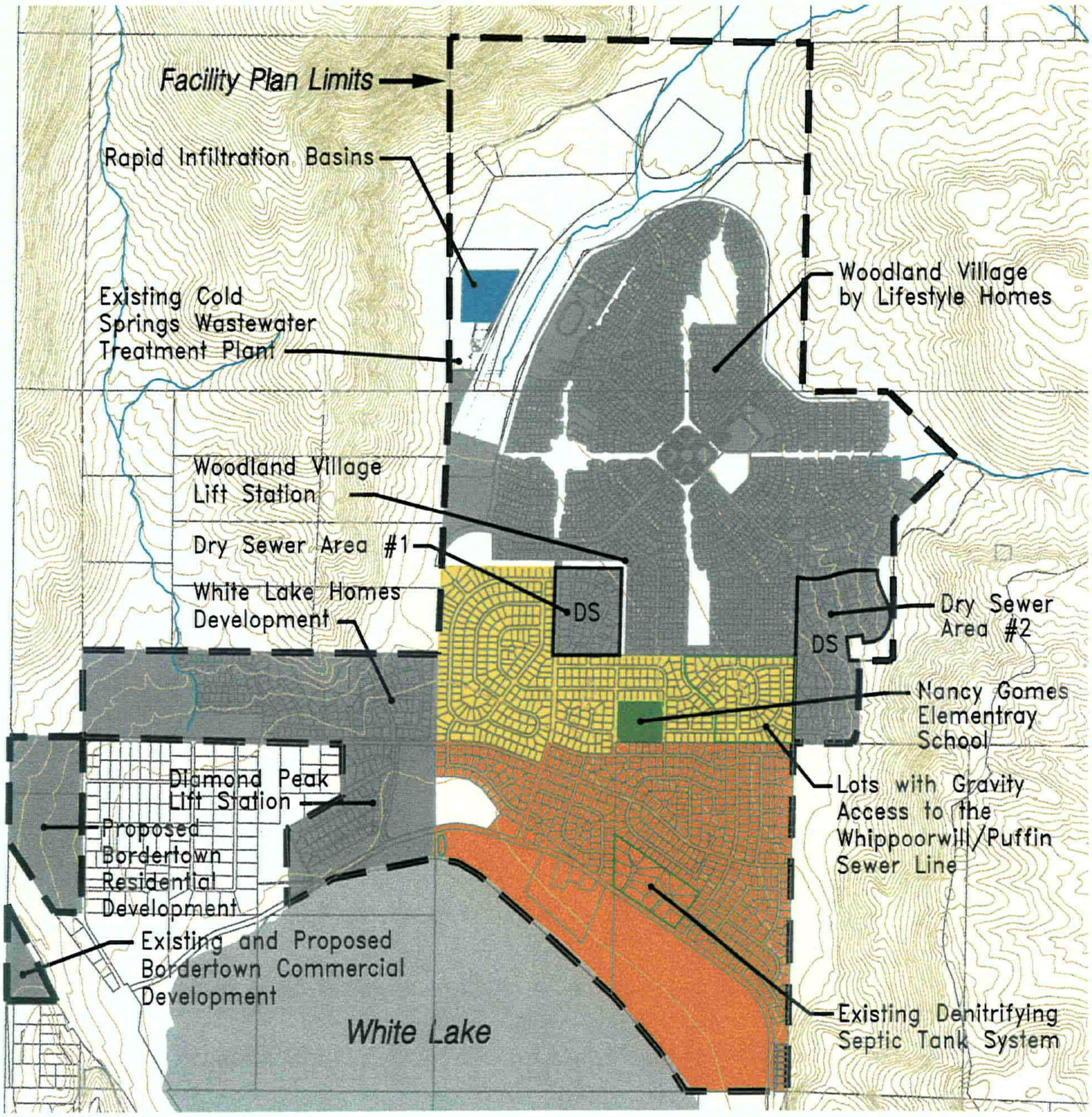
- Sewage collection and/or septic system conversion alternatives developed for the existing septic systems within the Facility Plan limits in Cold Springs to address the problem of groundwater pollution resulting from standard septic tank and leach field sewage treatment and disposal systems.

- Sewage collection systems developed for the existing Nancy Gomes Elementary School, the existing areas with dry sewers, and a portion of the existing area using septic systems with gravity access to an existing sewer main.

- A sewage collection system required for the existing Bordertown development and the planned expansion and residential development by Bordertown.

- Cost estimates for the collection/conversion alternatives.

- Evaluation and ranking of the collection/conversion alternatives according to specified criteria.



Legend

Existing Septic System Southern Portions

Existing Septic System Northern Portions

Existing and Future Sewered Lots

Rapid Infiltration Basins

Existing Dry Sewers

N

Not to Scale

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources

Facility Plan Map

K/J 007018.01
July 2002

Figure 1

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- A recommendation for wastewater facility improvements.
- A phasing plan for implementation of the recommended improvements.

1.3 Future Loading

Table 1 provides a summary of the existing and potential flows to the Cold Springs Wastewater Treatment Plant.

Table 1

Existing and Potential Flows in the Facility Plan Area

Source	Equivalent ERU's	Max Month Average Daily Flow
Existing and Future Lifestyle/Woodland Homes Developments	2,070	672,750
Existing and Future Residential Development from White Lake Homes	364	118,300
Dry Sewered Area #1	57	18,525
Dry Sewered Area #2	109	35,425
Lots Within the Facility Planning Limits Using Septic Tank and Leach Field Systems for Sewage Treatment and Disposal	883	286,975
Existing and Proposed Bordertown Improvements	304	98,800
Existing Lots with Gravity Access to the Whipporwill/Puffin Sewer Line	102	33,150
Nancy Gomes Elementary School	28	9,100
Potential Development along the North Side of White Lake	80	26,000
Total	**3,997**	**1,298,025**

Part One of the facility plan recommends an initial phase of treatment plant expansion increasing capacity by 450,000 gpd to a total treatment capacity of 0.80 MGD. A second phase of expansion increasing capacity another 0.45 MGD to a total plant capacity of 1.25 MGD would be required if all the homes using septic systems were converted to the community wastewater system. These phased expansions were established as a roughly equal split between future development and conversion of the existing septic systems in use.

Section 2: Background

2.1 Existing Wastewater Infrastructure

In the Cold Springs Valley there are the following three existing types of wastewater systems

1. Standard septic systems with leach field effluent disposal.
2. Denitrifying septic systems with leach field effluent disposal.
3. A community collection system, with the Cold Springs Wastewater Treatment Plant serving as the treatment facility. Effluent is land applied in rapid infiltration basins.

Part One of the facility plan provides information regarding each sewer system type in use in Cold Springs. The following subsections reference the corresponding Part One subsections describing the sewer system types.

2.1.1 Standard Septic Systems

The standard septic systems currently in use at Bordertown and at approximately 985 homes are described in section 2.2.1 of Part One of the facility plan.

2.1.2 Denitrifying Septic Systems

The existing denitrifying septic systems in the Cold Springs Valley are discussed in section 2.2.2 of Part One. The location of the denitrifying septic systems are shown in Figure 1. These systems have been included in the collection/conversion system analysis.

2.1.3 Collection System

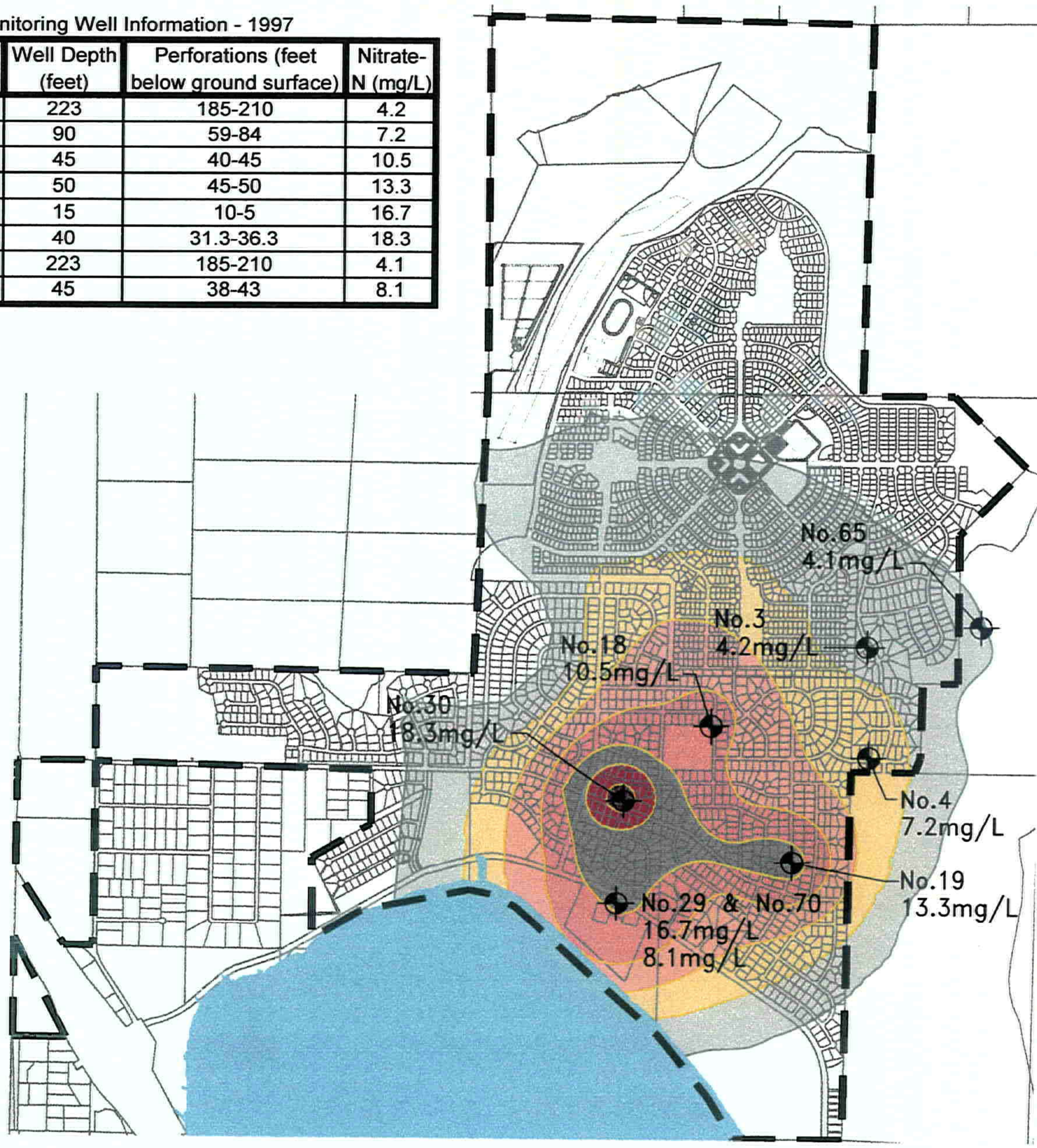
The existing collection system is described in section 2.2.4 of Part One.

2.2 Sewer Collection/Conversion System Alternatives

The Cold Springs Valley is a closed basin, with no surface water inflow or outflow. The Cold Springs basin experiences relatively high ground water in a good portion of the valley, although high groundwater does not occur within the Lifestyle/Woodland development. From the initial development of the Cold Springs Valley until 1996, all residences used individual septic tank/leach field systems. These systems discharge effluent to the soil, which percolates to the shallow groundwater. The increasing number of septic tanks, coupled with the rise in groundwater levels, caused an increase in nitrate concentrations in the near surface groundwater. Groundwater sampling by Washoe County in 1991, 1997 and 2001 identified the development of a plume of nitrate contamination that now exceeds the allowable standard of 10 mg/l nitrate-nitrogen. Refer to Figure 4 for location of the limits of the nitrate-N plume developed from monitoring conducted in 1997. In 2001 the maximum sampled nitrate level was over 30 mg/l. The groundwater nitrate contamination requires a plan be developed and actions taken to improve groundwater quality.

Monitoring Well Information - 1997

Well No.	Name	Well Depth (feet)	Perforations (feet below ground surface)	Nitrate-N (mg/L)
3	CC2	223	185-210	4.2
4	CC1	90	59-84	7.2
18	CSV2	45	40-45	10.5
19	CSV1	50	45-50	13.3
29	CSV6	15	10-5	16.7
30	CSV4	40	31.3-36.3	18.3
65	CC3	223	185-210	4.1
70	CSV7	45	38-43	8.1



Legend

Well Location

17.5-20.0

15.0-17.5

12.5-15.0

10.0-12.5

7.0-10.0

5.0-7.5

2.5-5.0

<2.5

NO_3 - N Concentration in mg/L

Notes

1). Concentration contours provided by Washoe County

2). Well Numbers Correspond to Figure 3 and Table 2

N

Not to Scale

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

Ground Water Nitrogen Concentration Contours 1997

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Figure 4

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The results of the hydrogeological analysis performed for the preparation of this facility plan indicated that by converting all existing septic tanks to a community sewer system, nitrates in the groundwater would be reduced to near zero within 4 years of the completion of the conversion of the septic tanks to a community sewer system. However, by converting only a portion of the existing septic tanks to the community sewer while leaving approximately half of the unconverted septic systems as is, the nitrates in the groundwater were projected to be at a concentration of approximately 12 mg/l in 20 years but were displaying a declining trend. This is above the 10 mg/l limit set by the NDEP and therefore, in order to solve the groundwater nitrate problem within a reasonable amount of time the septic tanks would need to be converted to either denitrifying septic systems or to the community wastewater treatment and disposal system.

Kennedy/Jenks Consultants developed six alternatives for sewage collection/conversion alternatives for the Cold Springs Valley. These alternatives are:

1. Converting all the existing septic systems to de-nitrifying septic systems as described in section 3.1.
2. Converting all the existing lots with septic tanks to a vacuum collection system for conveyance to and treatment and disposal at an expanded CSWWTP as described in section 3.2.
3. Converting all the existing lots with septic tanks to a grinder pump collection system for conveyance to and treatment and disposal at an expanded CSWWTP as described in section 3.3.
4. Converting all the existing lots with septic tanks to a gravity fed/two-lift station collection system for conveyance to and treatment and disposal at an expanded CSWWTP as described in section 3.4.
5. Converting all the existing lots with septic tanks to a gravity fed/four-lift station collection system for conveyance to and treatment and disposal at an expanded CSWWTP as described in section 3.5.
6. Converting the dry sewered area #2, the Nancy Gomes Elementary School and the residences with gravity access to the existing Whippoorwill/Puffin sewer main with associated collection system improvements for treatment and disposal at an expanded CSWWTP described in section 3.6.

These alternatives along with their estimated costs are detailed in the following sections. These alternatives are also evaluated according to following evaluation categories.

- groundwater contamination reduction potential
- cost
- reliability
- impact to residents

Associated sub-criteria falling under each major criteria are also considered in the evaluation of the alternatives. With scores assigned, a computer model determined the preferred alternative relative to the scores assigned and the weighted criteria.

Section 3: Conversion/Collection Systems Alternatives

A number of conversion/collection system alternatives were developed to identify the most cost effective method of reducing groundwater pollution problems resulting from the existing septic tank and leach field sewage treatment and disposal systems in use in portions of the Cold Springs valley. A series of Citizen Committee meetings were held to inform the public and solicit their input in the development and evaluation of conversion/collection system alternatives.

3.1 Conversion to Denitrifying Septic Tanks

This alternative would involve converting approximately 880 existing residential lots using septic tanks to denitrifying septic tanks. The remaining homes using septic tanks can be converted to the community wastewater system using the dry sewer lines currently in place. Denitrifying septic tanks are somewhat similar to standard septic tanks but have two chambers instead of one, however the treatment process is quite different. The first chamber is used for initial solids settling. The second chamber has mechanical equipment to provide a continuous cycle of treatment steps. These steps include the following.

1. Aeration and mixing are provided for rapid treatment of wastewater. Nitrogen in the form of ammonia is converted to nitrate by bacteria (nitrification). A stirring agitator or an air compressor is used to supply the oxygen to aerobic bacteria.

2. Mixing without aeration then provides the environment for bacteria to convert the nitrogen in nitrate to nitrogen gas (denitrification) and release it to the atmosphere.

3. Solids can be pumped from the unit or reduced to ash using a burner.

Most units are installed with some type of alarm or control system to detect mechanical breakdown and to control the electrical components. Depending on the actual system installed, the current septic tank may or may not be used as the settling chamber in the denitrifying system.

The advantage to using denitrifying septic tanks is that they produce a better quality effluent than conventional septic tanks. Recent tests in Ventura, California of six manufactured units detailed in the December 2001 issue of Water Environment and Technology indicated a range of effluent BOD from 5 to 59 mg/L and an average of 21.4 mg/L. The same study indicated effluent total nitrogen ranged from 11.3 to 19.6 mg/L with an average of 16.4 mg/L. For comparison, standard septic tanks are estimated to produce effluent with 140 to 200 mg/l BOD per Metcalf and Eddy Wastewater Engineering and 100 mg/L nitrate as nitrogen as cited in the Hydrogeological Analysis report prepared by Broadbent and Associates as part of this facility planning effort. These units can be used where soil and site restrictions prevent the use of traditional septic tanks, as in the Cold Springs area which has a high groundwater table and small lot sizes. These tanks, if working properly, would help protect future groundwater contamination by reducing the concentration of the nitrate in the effluent disposed in leach fields. They may also allow for a reduction in drain field size.

But if the second tank's agitator or air compressor fails, the quality of effluent will be no better than a standard septic tank. These systems require monitoring to insure the system is working correctly. Monthly sampling is suggested at least for the first couple of years. Thereafter quarterly monitoring and then less frequent monitoring may be implemented. The maintenance processes are more labor intensive than for standard septic systems and require semi-skilled personnel. Overall, these systems are more expensive to operate than standard septic systems. They are also susceptible to mechanical failure. Sudden heavy or discontinuous flows can disrupt the microbial environment, causing treatment failure. They also require electricity to be provided by the homeowner. If the current septic tanks are used as the settling chamber, the age of the tanks could also be an issue.

According to the results of the hydrogeological analysis discussed in the Facility Plan, if proper operation and maintenance of the individually owned denitrifying septic systems is provided, the groundwater nitrate contamination will be mitigated by reaching a low level concentration in four years after completion of the conversion of the standard septic tanks to denitrifying septic tanks. It should be noted that the effluent concentration used in the hydrogeological analysis was less than the average effluent concentrations described in the previous paragraphs.

Questions remain on whether denitrifying septic tanks can meet long-term performance standards. The Washoe County Department of Water Resources is developing a test program to determine the average effluent quality from the various denitrifying systems available on the market and the amount of operation and maintenance necessary to maintain an acceptable effluent quality.

3.2 Vacuum System Collection System

A vacuum collection system works under the premise of differential air pressure. The vacuum sewer lines are under a constant vacuum (16"- 20" Hg) created by vacuum pumps located at a central vacuum station. The pressure differential between atmospheric pressure and the vacuum in the sewer lines is 7-10 psi, which provides enough energy to transport sewage. A vacuum interface valve opens to expose the sewage to the vacuum system. Two adjacent lots would share a single vacuum interface valve.

A vacuum collection and transport system consists of three main components, the interface valve/sump, the vacuum piping, and the vacuum station. Sewage flows by gravity from the home into a collection sump. When enough sewage is collected to activate the vacuum interface valve located above the sump, the valve will automatically open and the air pressure differential moves the sewage through the valve to the vacuum main. The main vacuum station is similar in function to a lift station. Sewage pumps transfer the sewage from the vacuum collection tank through a force main to the treatment plant. But unlike a conventional lift station, the vacuum station has two vacuum pumps that create a vacuum in the sewer lines and the enclosed collection tank. This alternative would require an expansion of the CSWWTP. A schematic of the vacuum system house/pit/main relationship is shown in Figure 2.

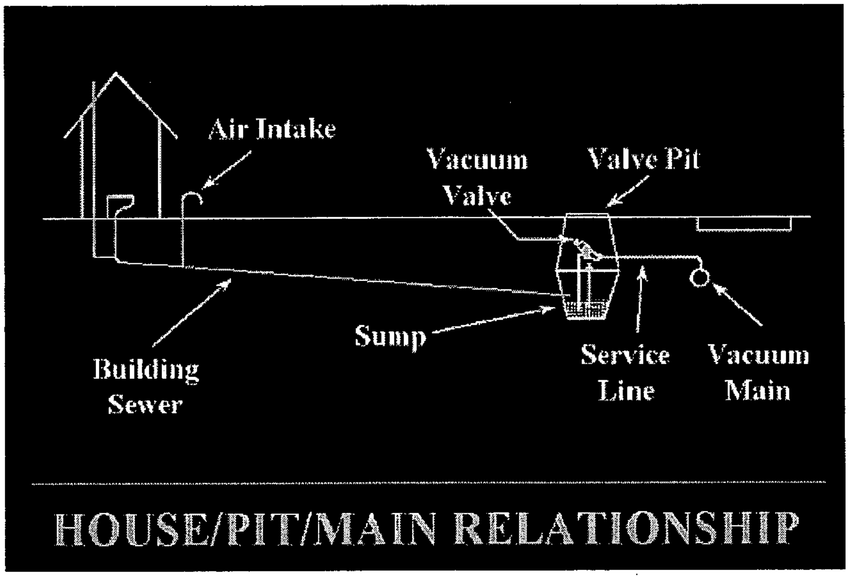


Figure 2. Vacuum Collection System House/Pit/Main Relationship

In regions that are difficult to sewer by gravity the vacuum system eliminates the need for lift stations and is a proven alternative to conventional sewer systems. There are no electrical connections required at the home. Power is necessary only at the vacuum station. Vacuum sewer lines are installed in narrow trenches in a saw tooth profile for grade and uphill transport. Vacuum lines follow grade for downhill transport.

There are several advantages to a vacuum collection system. Sewage velocities in the vacuum lines average 15-18 fps. These high velocities break the solids into small particles and pipeline clogs are rare. The pipes are also self cleaning due to this factor. The pipeline may be laid to convey sewage uphill as well as downhill and pipeline depths are typically only about 4 feet underground. This requires less excavation, and hence less cost and easier serviceability. Smaller diameter pipes are needed for the vacuum lines, offering another cost advantage. The vacuum system also does not require manholes or lift stations. Due to the amount of air that is necessary to drive the wastewater through the system, odor problems are reduced.

Potential disadvantages include possible limitation in system layout depending on extreme elevation changes in land to be serviced. In order to be cost effective, it is generally recommended that at least 75 properties be serviced per vacuum station. Regular maintenance is required by a skilled technician.

As part of the alternative development Kennedy/Jenks spoke with four separate agencies using vacuum sewers for their collection systems to get their opinion of their systems. All looked upon their vacuum collection systems very favorably. A common concern regarding vacuum collection systems are vacuum leaks. The leaks are most often the result of an obstruction keeping an interface valve open. The agencies contacted indicated that leaks are not difficult to locate and easily resolved. The agencies reported the interface valves have a good service life and are easily fixed if something goes wrong with them. The majority of their maintenance calls result in replacing the controller mechanism and the maintenance personnel have learned to keep a spare controller in the trucks because most often this is the problem. The controllers are more easily and cheaply replaced then repaired. One agency indicated they have both a vacuum system and a grinder pump system and they indicated the vacuum system is generally easier to maintain.

3.3 Grinder Pump Collection System

The grinder pump collection alternative is a low pressure sewer system that would involve installing grinder pumps at every residence and operating pressurized sewer lines to an expanded CSWWTP. The grinder pump assembly contains the grinder pump, motor controls, and a level sensor into one compact unit. This unit provides for wastewater storage, grinding, and pumping of the wastewater. The tank is typically made of fiberglass reinforced plastic and has a volume of up to 150 gallons. When the sewage level in the tank reaches a predetermined level, the grinder pump is activated. The pump grinds up the sewage into smaller particles, and pumps the resultant sewage to a pipe leading to a central treatment facility. A check valve is installed in each grinder pump assembly to prevent flow form the low pressure sewage conveyance system from backing into the grinder pump and its holding tank. Electrical power to the grinder pump assembly is provided by each individual homeowner. A breakered disconnect panel is installed that is independent from the residential breaker panel. Electrical power will typically run about $1.00/month. Figure 3 shows a typical grinder pump assembly.

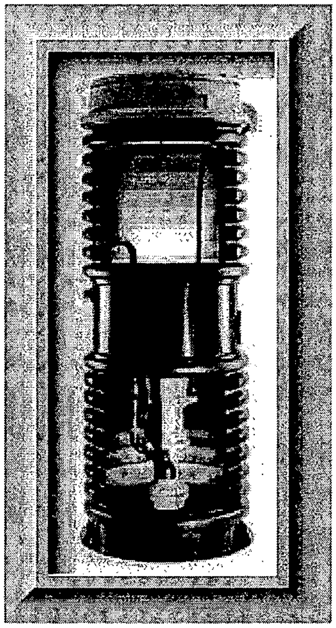


Figure 3. Grinder Pump Assembly

There are several advantages to a grinder pump collection system. Because the flow is pressurized, the pipes are self-cleaning. Pipeline clogs are rare. The pipeline can convey sewage uphill as well as downhill and pipeline depths are typically only about 4 feet underground. This requires less excavation, and hence less cost and easier serviceability. Another cost advantage is the system requires smaller diameter pipes for the sewage conveyance. The grinder pump system also doesn't require manholes or lift stations. Infiltration is also virtually eliminated due to a tight system design.

A large amount of mechanical equipment is a major disadvantage to the grinder pump collection system. Because there will be a grinder pump installed at each residence, the probability of required maintenance increases. Extended power outages also may cause a problem. The grinder pump holding tank would not be able to hold an excessive amount of sewage, and damage to the pump may result. If there is a power outage, the resident should not use any large flow appliances such as the laundry machine or dishwasher to avoid potential problems. Another disadvantage to the grinder pump system is that the electrical power is supplied by the resident, and hence the financial responsibility of the resident. Another disadvantage is that since the sewage conveyance is under pressure any line break can result in raw sewage being released.

Routine maintenance on the system is required, and maintenance would have to access the homeowner's property to perform maintenance. Control panels on the side of the house may cause aesthetic problems for some people.

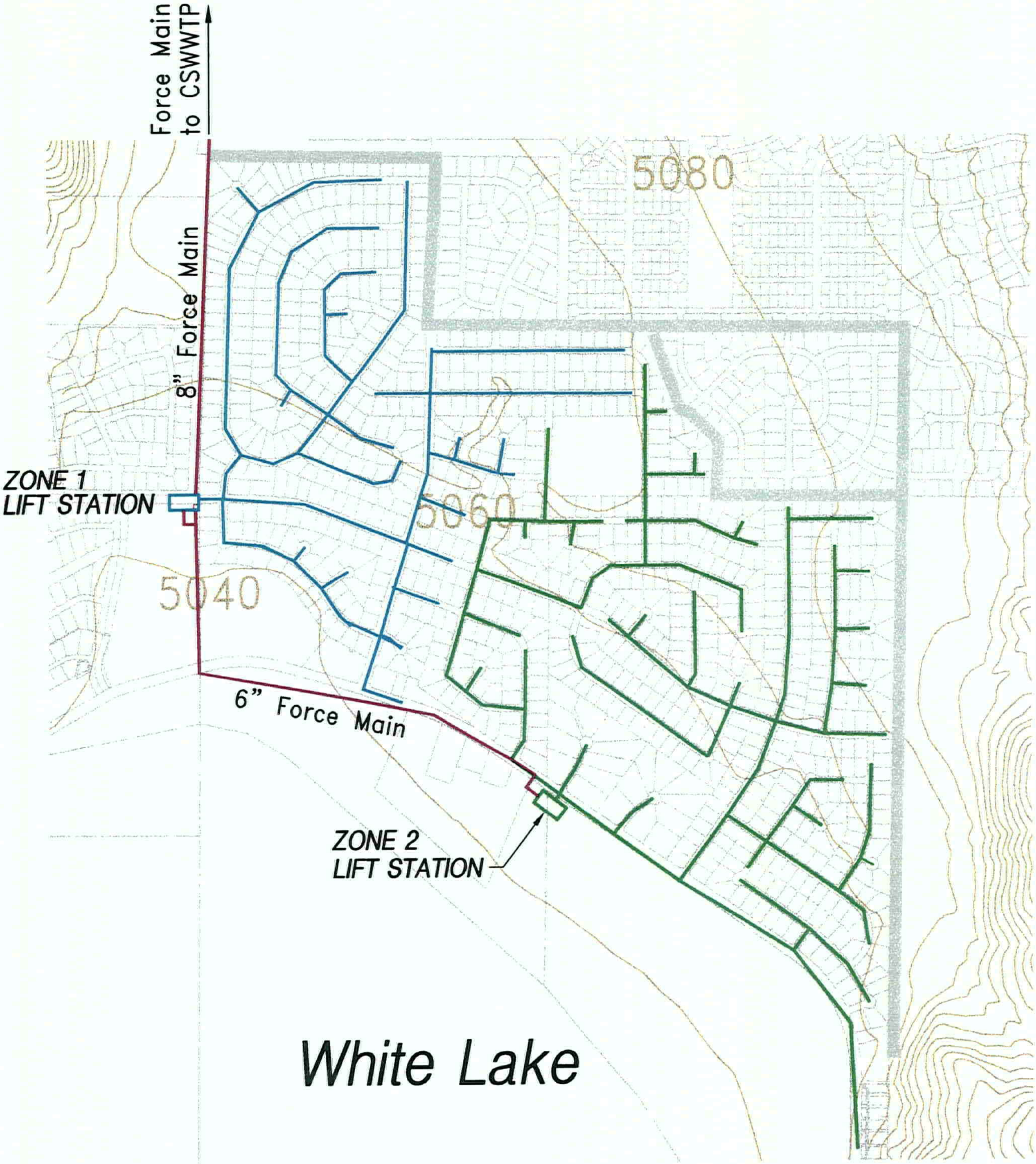
Similar to the vacuum systems, Kennedy/Jenks spoke with maintenance personnel of four separate agencies using a grinder pump system for sewage conveyance. The operators generally looked upon their systems favorably. One indicated that the E/One brand of pumps they use are reliable and efficient and that replacement parts are readily available. When queried none of then operators had anything negative to say about their grinder pump systems.

3.4 Gravity/Two Lift Station Collection System

A conventional gravity sewer collection system collects and transports sewage to a wastewater treatment plant via gravity. The system includes lateral pipes, collection lines, interceptors, manholes, and if required pump stations. Laterals are the pipes that move wastewater from the homes to the collection system. The collection system includes pipes that carry the wastewater to the interceptors, which then carry the wastewater to the treatment plant with or without the help of pump stations contingent upon the relative elevation of the treatment facility. The pipes are installed at such a gradient to provide a self-cleaning velocity. Lift stations include pumps, valves, a wet well to hold incoming sewage, and by Washoe County standards an emergency power supply and emergency storage facilities. Manholes are located a maximum of 550 feet apart along the sewer collection system to allow access for cleaning. The minimum pipe diameter for the Cold Springs area would be 8 inches, and for the preliminary design were sized based on minimum velocity requirements. This alternative consists of a conventional gravity collection system with two lift stations transporting sewage to an expanded CSWWTP.

Gravity collection systems with centralized lift station facilities offer the advantage of being well accepted by utilities and the public, and the technology is proven. Energy requirements and O&M costs are generally considered low. However, as the number of lift stations increase, O&M cost also increases.

Gravity/lift station systems may have infiltration and inflow problems, as well as odor concerns. The gravity piping system often requires deep excavation. This could cause a potential problem in the Cold Spring area, where there is a very high groundwater table. The two lift station alternative results in gravity flow pipes approaching a maximum depth of approximately 24 feet below the existing ground surface. This deep excavation also increases capital costs, and construction time. Figure 5 shows the configuration of the gravity/two lift station alternative.



Legend

ZONE 1 (8" COLLECTION LINES)

ZONE 2 (8" COLLECTION LINES)

SEWER FORCE MAIN

CSWWTP COLD SPRINGS WASTEWATER TREATMENT FACILITY

N

Not to Scale

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

2 Lift Station - Gravity Sewer

K/J 007018.01
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Figure 5

P:\007018.01\Facility-Plan-Addendum\2 Lift Station Sewer.dwg

3.5 Gravity/ Four Lift Station Collection System

The gravity/4-lift station collection alternative is based on the same concept of the gravity/2-lift station discussed in the previous section. The only difference is this alternative would have four lift stations. Each station would have to lift less sewage than in the 2-lift alternative. Using the four lift station configuration results in a maximum pipe depth approaching 14 feet below the existing ground. Therefore the sewage conveyance pipelines for the 4-lift station alternative are cheaper to construct than the 2-lift station alternative. However, the estimated operation and maintenance costs are slightly greater because of more stations to maintain. Figure 6 shows the configuration of the gravity/four lift station alternative.

3.6 Conversion of School, Dry Sewered Area and Gravity Access Alternative

A final alternative was developed based largely on input by the public at the Citizen's Committee meetings held as part of the facility planning process. Analysis of the nitrate plume map prepared by the Washoe County Department of Water Resources using data generated from monitoring well samples taken in 2001 showed a change of shape of the plume. The 2001 plume map identifies the Nancy Gomes Elementary School as a possible major source of nitrate contamination. This alternative considers conversion of the Nancy Gomes Elementary School along with the dry sewer area #2 and the existing lots with gravity flow access to the existing Whipporwill/Puffin sewer line.

The following subsections describe the three components of this alternative.

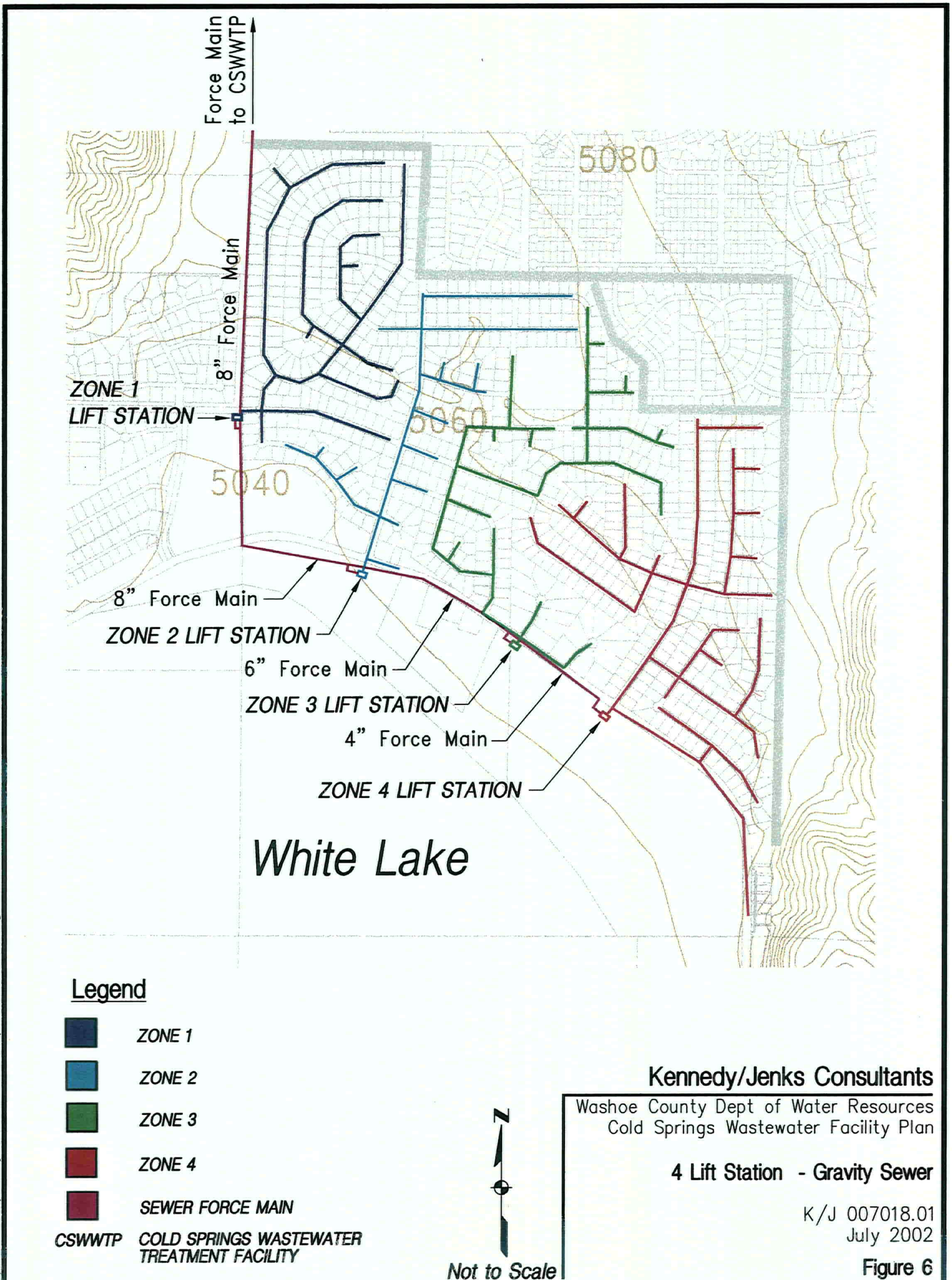
3.6.1 Nancy Gomes Elementary School

The Nancy Gomes Elementary School in Cold Springs has a 9,000 gallon septic tank and leach field for disposal of sanitary waste. This alternative calls for the school to connect to the existing sanitary sewer to the northeast of the property. Gravity access to the existing collection system is possible. Figure 7 shows the alignment of the proposed connection.

3.6.2 Dry Sewered Areas

There are two separate areas with existing dry sewer lines as shown in Figure 1. Dry sewer area #2 (also known as the Crystal Canyon development) was constructed with relatively easy conversion to a community sewer system. The existing Whippoorwill/Puffin sewer line was constructed to convey flow from these residential lots to the Woodland Village Lift Station. The Woodland Village Lift Station was sized to provide capacity for conveyance of sewage from these homes to the CSWWTP. The trust deeds for these properties require connection to the community sewer when it becomes available however as of Spring 2002 only a couple of the homes have connected to the community sewer system.

Dry sewer area #1 does not have gravity access to the existing Whippoorwill/Puffin sewer line. The existing dry sewer lines in place are sloped to the south and the depth at the terminus of the dry sewer lines is approximately 3 feet below the Whippoorwill/Puffin sewer line. In order to convey flow from these lots a lift station would be required to produce the lift necessary for connection to the Whippoorwill/Puffin sewer line. This facility plan does not address the infrastructure improvements required to convey sewage flows from dry sewer area #1.



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Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

4 Lift Station - Gravity Sewer

K/J 007018.01
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Figure 6

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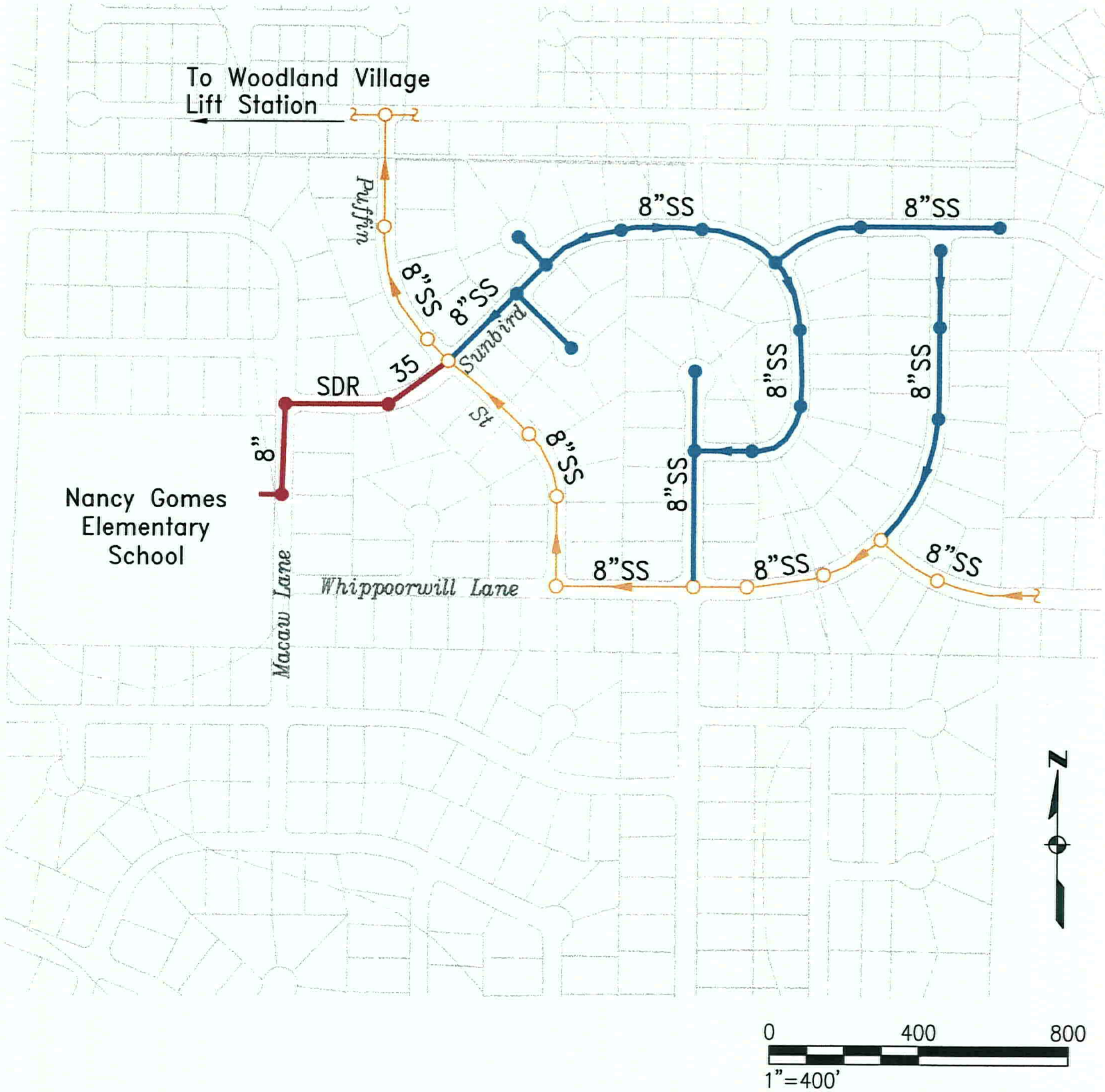
3.6.3 Existing Developed Lots with Gravity Access to Whippoorwill/Puffin Sewer Line

There are 102 existing residential lots located in the northeast corner of the area of existing septic system area as shown on Figure 1. These residences have gravity access to the Whippoorwill/Puffin sewer line and conveyance capacity at the Woodland Village lift Station has been allocated for these homes along with the homes in the Crystal Canyon development. At the present time there are no dry sewer lines in place for use in this location. Figure 7 shows the collection system improvements required to convey sewage from these homes to the CSWWTP.



Legend

NEW PIPING AND MANHOLE (8" SDR 35)
EXISTING PIPING AND MANHOLE (8"SS)
PROPOSED PIPING AND MANHOLE (8"SS)

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan
Connection of Nancy Gomes Elementary School and Lots with Gravity Access to Existing Sewer Line
K/J 007018.01
July 2002
Figure 7

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Section 4: Bordertown Improvements

4.1 Bordertown Improvements and Connection to the Existing Community Wastewater System

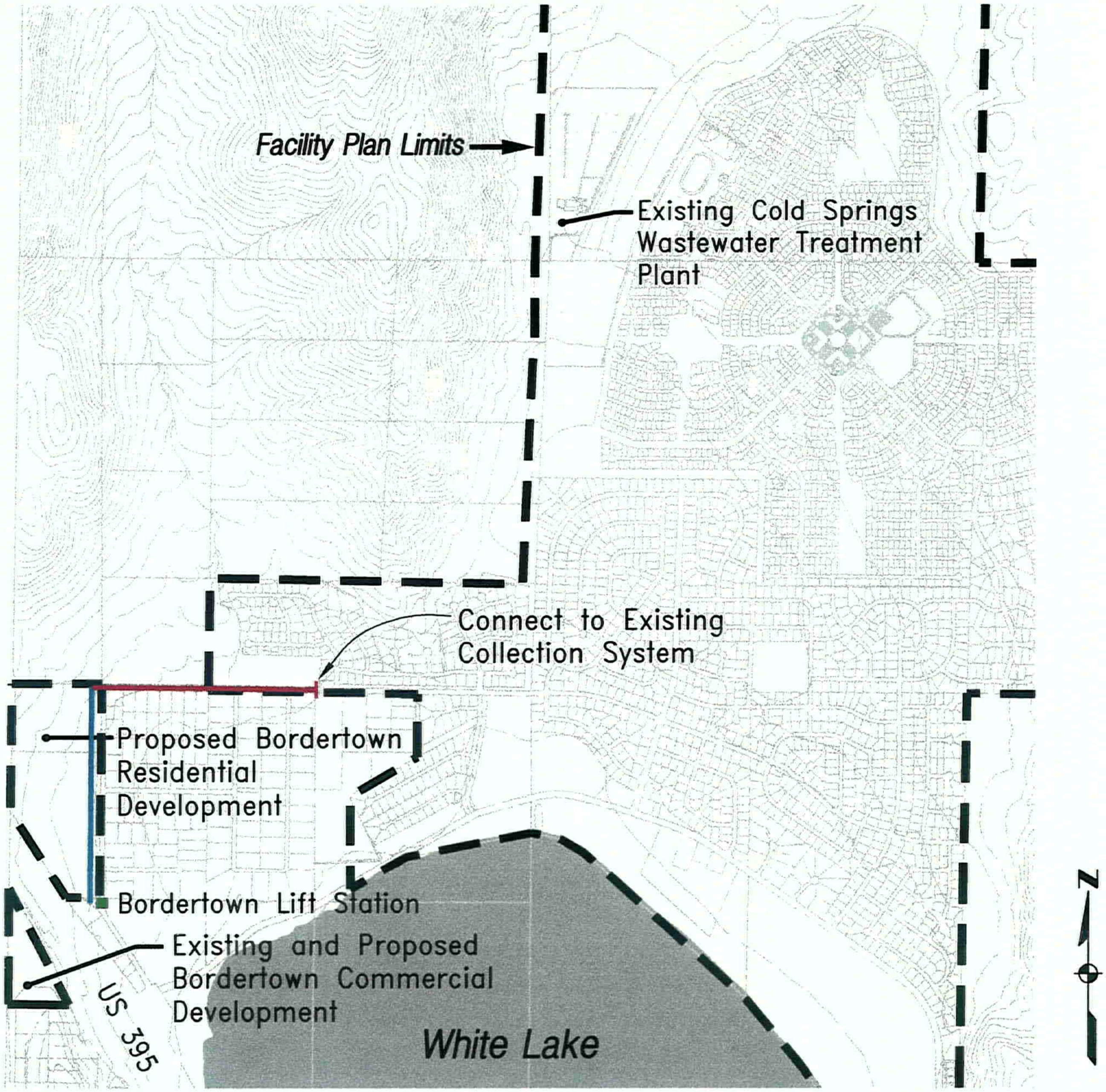
Bordertown is considering an expansion of their existing commercial development resulting in a 50 Unit RV Park, a 10,000 square foot casino expansion, a 5,000 square foot restaurant and kitchen, a 150 room hotel, and a mini market. Bordertown is also planning a 171 unit residential subdivision to be constructed across the highway from the existing casino. The total flow from Bordertown is approximately 100,000 gallons per day as detailed in Part One.

A report by Gunderson and Associates, Ltd (1999) evaluated three options for wastewater treatment and disposal and identified the best option was connecting to the Cold Springs Wastewater Treatment Plant. Connection to Washoe County system would require paying the Washoe County connection fee which is currently $4,700 per equivalent residential unit (ERU). The connection fee covers the costs incurred by Washoe County to collect and treat the wastewater. As of July 2002 the proposed Bordertown commercial expansion and residential development have been tentatively assigned ERU values of 133 and 171 respectively. The assigned values are tentative and subject to change as development plans are finalized. Using the tentative ERU count the revenue generated by connection fees at the current connection fee rate would be $1.43 million.

Figure 9 shows the probable improvements to be constructed to connect to the existing wastewater collection system. The improvements would generally include a collection system, a lift station with a required pump capacity of 206 gpm, a 2,600 linear foot section of 6-inch diameter force main and a 2,700 linear foot section of 8" gravity main. The 8-inch gravity main would connect to the existing collection system within the White Lake Homes subdivision. The cost of these improvements would be borne by Bordertown as offsite improvements necessary to connect to the existing Washoe County collection system. The estimated cost of these improvements are not included in this facility plan.

4.2 Evaluation of Bordertown Collection System Using the Diamond Peak Lift Station

The connection of Bordertown generated wastewater flows to the existing Washoe County wastewater collection system discussed in subsection 4.1 would require improvements to the existing Diamond Peak Lift Station. The Diamond Peak Lift Station would then pump the sewage to the Cold Springs Wastewater Plant for treatment and disposal. This section addresses the improvements necessary to rehabilitate the Diamond Peak lift station. These improvements would be the financial responsibility of the Washoe County Department of Water Resources Utilities Division as part of system improvements including CSWWTP expansion and could be financed with the connection fee revenue.



NOTE

THIS FIGURE DOES NOT SHOW THE PIPELINE REQUIRED TO CONVEY FLOWS FROM THE BORDERTOWN COMMERCIAL DEVELOPMENT UNDER THE HIGHWAY ON THE COLLECTION SYSTEM IN THE PROPOSED BORDERTOWN RESIDENTIAL DEVELOPMENT TO LIFT STATION #1.

LEGEND

8" GRAVITY MAIN
6" FORCE MAIN

Kennedy/Jenks Consultants

Washoe County Dept of Water Resources
Cold Springs Wastewater Facility Plan

Bordertown Connection to Existing Sewer

K/J 007018.01
July 2002

Figure 9

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The Diamond Peak Lift Station is a wet pit, dry pit pump station type. The wet pit is a six-foot diameter manhole with 3.3 feet of operational storage. A prefabricated underground pump station in a separate structure is installed next to the wet pit. Both sit on a common slab. The pump station has two pumps each capable of pumping 275 gallons per minute. The sewage is pumped approximately 7,450 feet via a 6-inch force main to a manhole where it then flows by gravity to the Cold Springs Wastewater Treatment Plant.

A typical lift station wet pit and dry pit pump configuration is designed for a given flow rate and a specific maximum number of starts per hour. Normal operation is for the wet pit to fill up to a given level and then the volume is pumped out and the cycle is repeated. The pumps are designed for the maximum flow rate anticipated. Too small of a pit results in excessive starts per hour and wear on the motors. With higher flows, above the design rate, the sewage can back up into the sewers, possibly flooding houses.

The proposed flows from Bordertown total 101, 275 gallons per day or approximately 70 gallons per minute averaged over a full 24-hour day. Per Washoe County standards, a peaking factor of 3.0 is applied to the average flow to establish the pump capacity required for the pumps in a lift station. Applying this to the anticipated flows, the capacity required for a single pump is 210 gpm. Each lift station has two pumps to provide 100% redundant pumping capacity.

The Diamond Peak Lift Station has 275 gpm pumps and is sized for its service area which is the White Lakes Homes subdivision. The pumps must be upsized to accommodate the increased flow from Bordertown to a total of 485 (210+275) gallons per minute. The existing force main would then also have to convey the additional flow to the CSWWTP. The friction head resulting from this flow is 197 feet, using a conservative value of 100 for the C factor in the Hazen Williams formula, with a static lift of 50 feet the total discharge head required is 247 feet. A search of commonly available sewage pumps could not find a pump to match the head and flow requirements. If a pump could be found, the required motor would be 50 horsepower assuming a 70 % efficiency. The Diamond Peak station has an emergency power generator that would have to be upsized to accommodate the increased horsepower requirement.

A sewage pump station should have four hours of emergency storage at the average flow rate as a contingency in case the emergency power generator is not operational. Given the Diamond Peak and Bordertown flows total 162 (92+72) gpm, four hours of storage equals 38,800 gallons. It should be noted that currently there is no emergency storage at the Diamond Peak Lift Station.

A sump is properly sized for no more than five starts per hour. The maximum number of pump starts occurs when the flow is one half the design flow rate which in this case is 243 (485/2) gallons per minute. Five starts per hour means operation every 12 minutes and results in a required operating value of 2,916 (12 x 243) gallons. The Diamond Peak Lift Station currently has an operating value of 700 gallons.

Given the flow and storage requirements the Diamond Peak Lift Station is deficient in operating volume, force main size, emergency storage and pump capacity and cannot be used for the Bordertown expansion without major modification. The expansion of the existing Diamond Peak lift station is not practical considering the site constraints and the requirement to keep the facility in operation during construction. Therefore a cost analysis of expanding the existing lift station has not been prepared. Alternatively, a new lift station could be constructed to convey flow from Bordertown and White Lake Homes which is described in the following subsection.

4.3 Proposed Improvements for Conveyance of Flow from Bordertown and White Lake Homes to the Cold Springs Wastewater Treatment Plant

The Bordertown commercial enterprises are on the opposite side of the freeway of the CSWWTP as shown in Figure 9. This facility plan does not address conveyance of flows from the commercial development to the treatment plant side of the highway. An existing duct bank has been proposed as a possible avenue for conveyance of flows under the freeway but has not been examined in detail for feasibility. Additionally, as discussed in subsection 4.1, this facility plan does not include the preliminary design or estimated costs of a sewage collection system for the proposed Bordertown residential development or the pump station/force main/gravity main improvements required to convey flow to the existing collection system. This subsection describes in the infrastructure improvements required to be constructed by Washoe County to convey flow from Bordertown and White Lake Homes to the CSWWTP.

The new lift station would consist of a 12-foot square (inside dimension) sump with a 3-foot operating range. The invert of the lift station would be approximately 20 ft deep. The wet well would have 1-foot thick walls and would be lined with PVC sheeting to prevent corrosion and concrete degradation. The pump station would be pre-fabricated and contain two pumps with each pump having a capacity of 485 gpm with a total discharge head of approximately 80 feet. There would be an emergency power generator and four hours of emergency storage capacity provided. The emergency storage capacity could be provided using a 5-foot diameter pipe 120 feet long. The emergency storage would have to be positioned so when full it would not flood any houses and still be able to drain back into the lift station. Depending on the exact location of the station, some of the wet well could be used for emergency storage. The flow from the pump station would be convened to the CSWWTP in a 7,500 foot long, 8-inch diameter force main. In this analysis, no emergency storage in the wet well was assumed. A breakdown of estimated costs are provided in Table 2. The estimated costs presented do not include construction de-watering, land acquisition costs or any special construction requirements.

Table 2

Estimated Costs of Existing Collection System Improvements to Convey Bordertown and White Lake Homes Sewage to the Cold Springs Wastewater Treatment Plant

Item	Estimated Cost	
Pre-Fabricated Underground Station	$135,000	
Wet well	$140,000	
Emergency Generator and Transfer Switch	$50,000	
Landscaping	$10,000	
Fencing and Site Work	$15,000	
Flow Meter and Pigging Vault	$10,000	
Emergency Storage (120 ft at $300/ft)	$36,000	
Miscellaneous Piping	$5,000	
Electrical and Controls	$30,000	
Lift Station Subtotal	$431,000	
Force Main (7,500 ft at $40/ft)	$300,000	

Table 2

Estimated Costs of Existing Collection System Improvements to Convey Bordertown and White Lake Homes Sewage to the Cold Springs Wastewater Treatment Plant

Item	Estimated Cost	
Collection and Conveyance Cost Subtotal	$731,000	
Contingency (at 20%)	$146,000	
Design/Permitting/CM (at 20%)	$146,000	
Total Collection and Conveyance Capital Cost	**$1,023,000**	

Section 5: Collection/Conversion Alternative Costs

This section provides the estimated costs for each of the alternatives presented in Section 3. The final section provides a comparison of the estimated costs. It should be noted that the estimated O&M costs are based on anticipated energy requirements and labor costs. The costs presented do not include administrative and other overhead costs and are generally less than existing sewer fees charged in Washoe County.

5.1 Denitrifying Septic Tanks Cost

The capital cost for each denitrifying septic system is estimated to be approximately $6,000, with a monthly operation and maintenance (O&M) cost of $83. Denitrifying septic systems range from $2,000 to $10,000 and the $6,000 figure was used as an average. The estimated monthly operating cost includes monthly sampling and testing of the effluent. Currently no regulations in Washoe County are in place governing the operation and maintenance of denitrifying septic tanks. In discussions with officials at the Washoe County District Health Department a phased monitoring program would probably put into place. A proposed phased monitoring would require monthly sampling for two years, quarterly sampling for the following two years, semi-annual sampling the following two years and annual testing thereafter. With $44 allocated for testing and $39 allocated for monthly operation and maintenance averaged over a 20-year period results in a monthly operating cost of approximately $49. The number of homes that would be converted to denitrifying tanks is 883. This gives a total capital cost of $5,298,000 and a 20-year present value O&M cost of $6,470,429. Therefore, the total present value to covert the homes in Cold Springs to denitrifying septic tanks is $11,768,629. Table 3 provides a summary of these costs.

Table 3

Denitrifying Septic Tank Conversion Costs

Item	Cost
Capital Costs	
Capital Cost of Conversion	$5,298,200
Capital Cost to Upgrade Treatment Plant	$0
Capital Cost to Abandon Septic Tank and Construct Lateral	$0
Total Capital Cost per household[1]	$6000
O&M Costs	
O&M Cost per Year for Treatment Plant	$0
O&M Cost per Year (denitrifying septic system and monitoring)	$519,204
O&M Cost per Household per Year	$588
O&M Cost Per Household per Month	$49
Washoe County Sewer Fee per month as of Spring 2002	$26
Present Value Analysis	
Present Value of O&M Costs (20 years, 5%)	$6,470,429
Total Present Value[2]	$11,768,629
Grant Funding Analysis	

Table 3 Denitrifying Septic Tank Conversion Costs	
Item	Cost
Capital Cost per Household with 55% Grant Funding[3]	(not grant eligible)
Capital Cost per Household with 75% Grant Funding[3]	(not grant eligible)

NOTES:

1 The total capital cost per household is the average capital cost per household for denitrifying septic system installation.

2 The total present value includes the capital cost of conversion and the 20-year present value of operation and maintenance.

3 These line items indicate the upfront cost per household with the given stated level of grant funding. It is derived using the total capital cost per household value.

5.2 Vacuum System Collection Cost

AIRVAC Vacuum Systems provided a detailed cost estimate to Kennedy/Jenks to convert 883 homes with septic tanks and the Nancy Gomes Elementary School to a central vacuum system. A detailed cost estimate of both capital and O&M costs of the system is provided in Table 4. The cost estimate is for major vacuum system components, items such as final surface restoration, road crossings, other incidental costs are included in the contingency.

Table 4 Estimated Costs for the Vacuum System Alternative	
Item	Cost
Capital Costs	
Capital Cost of Conversion	$4,090,300
Capital Cost to Upgrade Treatment Plant	$4,387,800
Capital Cost to Abandon Septic Tank and Construct Lateral	$1,821
Total Capital Cost	$8,479,921
Total Capital Cost per household[1]	$9,603
O&M Costs	
O&M Cost per Year for Treatment Plant	$102,500
O&M Cost per Year (other than Treatment Plant)	$46,300
O&M Cost per Household per Year	$160
O&M Cost Per Household per Month	$13.33
Washoe County Sewer Fee per month as of Spring 2002	$26

Table 4 Estimated Costs for the Vacuum System Alternative	
Item	**Cost**
Present Value Analysis	
Present Value of O&M Costs (20 years, 5%)	$1,854,377
Total Present Value[2]	$10,334,298
Grant Funding Analysis	
Capital Cost per Household with 55% Grant Funding[3]	$4,321
Capital Cost per Household with 75% Grant Funding[3]	$2,401

NOTES:

1 The capital cost per household is the total capital cost per household for collection system installation, treatment plant expansion, septic tank abandonment and lateral construction.

2 The total present value includes the capital cost of conversion, treatment plant expansion, septic tank abandonment costs, the cost to construct a lateral from the household to the sewer main, and the 20 year present value of operation and maintenance.

3 These line items indicate the upfront cost per household with the given stated level of grant funding. It is derived using the total capital cost per household value.

5.3 Grinder Pump System Collection Cost

E/One Sewer Systems provided Kennedy/Jenks Consultants with a detailed cost estimate to convert the existing homes on septic tanks to a grinder pump collection system. This alternative would also involve expanding the CSWWTP and abandoning the current septic tanks. The estimated costs are summarized in Table 5.

Table 5 Estimated Costs for the Grinder Pump Alternative	
Item	**Cost**
Capital Costs	
Capital Cost of Conversion	$6,307,549
Capital Cost to Upgrade Treatment Plant	$4,387,800
Capital Cost to Abandon Septic Tank and Construct Lateral	$1,821
Total Capital Cost	$10,697,170
Total Capital Cost per household[1]	$12,115
O&M Costs	
O&M Cost per Year for Treatment Plant	$102,500

Table 5 Estimated Costs for the Grinder Pump Alternative	
Item	**Cost**
O&M Cost per Year (other than Treatment Plant)	$70,012
O&M Cost per Household per Year	$195
O&M Cost Per Household per Month	$16.25
Washoe County Sewer Fee per month as of Spring 2002	$26
Present Value Analysis	
Present Value of O&M Costs (20 years, 5%)	$2,149,881
Total Present Value[2]	$12,847,051
Grant Funding Analysis	
Capital Cost per Household with 55% Grant Funding[3]	$5,451
Capital Cost per Household with 75% Grant Funding[3]	$3,028

NOTES:

1 The capital cost per household is the total capital cost per household for collection system installation, treatment plant expansion, septic tank abandonment and lateral construction.

2 The total present value includes the capital cost of conversion, treatment plant expansion, septic tank abandonment costs, the cost to construct a lateral from the household to the sewer main, and the 20 year present value of operation and maintenance.

3 These line items indicate the upfront cost per household with the given stated level of grant funding. It is derived using the total capital cost per household value.

5.4 Gravity/2-Lift Station Alternative

The cost estimates for the gravity/2-lift station alternative are based on prior experience in this field. Detailed cost estimates can be found in the Appendix. Table 6 summarizes the cost estimates for this collection system alternative.

Table 6 Estimated Costs for the Gravity/2-Lift Station Alternative	
Item	**Cost**
Capital Costs	
Capital Cost of Conversion	$8,841,250
Capital Cost to Upgrade Treatment Plant	$4,387,800
Capital Cost to Abandon Septic Tank and Construct Lateral	$1,821
Total Capital Cost	$13,230,871
Total Capital Cost per household[1]	$14,984

Table 6 Estimated Costs for the Gravity/2-Lift Station Alternative	
Item	Cost
O&M Costs	
O&M Cost per Year for Treatment Plant	$102,500
O&M Cost per Year (other than Treatment Plant)	$50,100
O&M Cost per Household per Year	$173
O&M Cost Per Household per Month	$14.42
Washoe County Sewer Fee per month as of Spring 2002	$26
Present Value Analysis	
Present Value of O&M Costs (20 years, 5%)	$1,901,733
Total Present Value[2]	$15,132,604
Grant Funding Analysis	
Capital Cost per Household with 55% Grant Funding[3]	$6,743
Capital Cost per Household with 75% Grant Funding[3]	$3,746

NOTES:

1 The capital cost per household is the total capital cost per household for collection system installation, treatment plant expansion, septic tank abandonment and lateral construction.

2 The total present value includes the capital cost of conversion, treatment plant expansion, septic tank abandonment costs, the cost to construct a lateral from the household to the sewer main, and the 20 year present value of operation and maintenance.

3 These line items indicate the upfront cost per household with the given stated level of grant funding. It is derived using the total capital cost per household value.

5.5 Gravity/4-Lift Station Alternative

Kennedy/Jenks Consultants determined the cost estimates for the gravity/4-lift station alternative based on prior experience in this field. Detailed cost estimates can be found in the Appendix. Table 7 summarizes the cost estimates for this collection system alternative.

Table 7 Estimated Costs for the Gravity/4-Lift Station Alternative	
Item	**Cost**
Capital Costs	
Capital Cost of Conversion	$6,686,535
Capital Cost to Upgrade Treatment Plant	$4,387,800
Capital Cost to Abandon Septic Tank and Construct Lateral	$1,821
Total Capital Cost	$11,076,156
Total Capital Cost per household[1]	$12,544
O&M Costs	
O&M Cost per Year for Treatment Plant	$102,500
O&M Cost per Year (other than Treatment Plant)	$53,800
O&M Cost per Household per Year	$177
O&M Cost Per Household per Month	$14.75
Washoe County Sewer Fee per month as of Spring 2002	$26
Present Value Analysis	
Present Value of O&M Costs (20 years, 5%)	$1,947,843
Total Present Value[2]	$13,023,999
Grant Funding Analysis	
Capital Cost per Household with 55% Grant Funding[3]	$5,645
Capital Cost per Household with 75% Grant Funding[3]	$3,136

NOTES:

1 The capital cost per household is the total capital cost per household for collection system installation, treatment plant expansion, septic tank abandonment and lateral construction.

2 The total present value includes the capital cost of conversion, treatment plant expansion, septic tank abandonment costs, the cost to construct a lateral from the household to the sewer main, and the 20 year present value of operation and maintenance.

3 These line items indicate the upfront cost per household with the given stated level of grant funding. It is derived using the total capital cost per household value.

5.6 Conversion of the School, Dry Sewer Area #2 and the Lots with Gravity Access to the Whippoorwill/Puffin Sewer Line

The estimated cost of this alternative is broken down into its three separate components described in the following three subsections.

5.6.1 Conversion of the School

The estimated cost of converting the Nancy Gomes Elementary School is provided in Table 8.

Table 8

Estimated Costs for Connecting the Nancy Gomes Elementary School

Item	Quantity	Unit Cost	Total
Capital Improvements			
8-Inch SDR 35 Sewer (feet)	800	$80	$64,000
Manhole (each)	3	$5,000	$15,000
Connect to Existing (each)	1	$5,000	$5,000
Pavement Cutting (feet)	1600	$1	$1,600
Pavement Patching (sq ft)	6400	$2	$12,800
Subtotal Off Site Construction Cost			$98,400
Contingency (at 20@)			$19,700
Design/Permitting/CM (at 20%)			$19,700
Total Off Site Costs			$236,200
Expanded Plant Capacity Cost (28 ERU's)			$138,000
Total Capital Cost			$374,200
O&M Costs			
Anticipated Monthly O&M Cost			$26
Present Value Analysis			
20 Year Present Value of O&M Cost			$3,888
Total Present Value			**$378,088**

5.6.2 Conversion of Dry Sewer Area #2

The cost of converting dry sewer area #2 is set by the standard Washoe County connection fee which is $4,700 as of Spring 2002. This cost is the obligation of the property owner by trust deed and is not included in the estimated costs for this alternative.

5.6.3 Conversion of the Residences with Gravity Access to the Whippoorwill/Puffin Sewer

The cost of converting the existing residences with gravity access to the Whippoorwill/Puffin sewer line is provided in Table 9.

Table 9 Estimated Costs for Connection of Existing Lots with Gravity Access to the Whipporwill/Puffin Sewer Line			
Item	Quantity	Unit Cost	Total
Capital Costs			
Manholes (each)	17	5,000	$85,000
Pavement Cutting (feet)	8,300	1	$8,300
Pavement Patching (sq ft)	66,400	2	$132,800
8" SDR 35 Sewer	4,150	80	$332,000
Break and Enter Manholes	3	5,000	$15,000
Subtotal			$573,100
Contingency (at 20%)			$114,620
Design/Permitting/CM (at 20%)			$114,620
Sewer Total Cost			$802,340
Cost of Plant Expansion			$507,000
Total Capital Cost			$1,309,340
Capital Cost per Residence (102 units)			$12,837
O&M Cost			
Monthly Sewer Fee per ERU			$26
Present Value Analysis			
20 Year Present Value of Monthly Sewer Fee			$396,597
Total Present Value			**$1,705,937**

5.7 Summary

Table 10 compares the estimated costs for all alternatives in this analysis.

Table 10 Comparison of the Estimated Costs for the Cold Springs Collection/Conversion Alternatives						
Item	Denitrifying Septics	Vacuum System	Grinder Pump	Gravity Two Lift	Gravity Four Lift	School & Whipporwill
Capital Cost	$5,298,000	$8,480,000	$10,697,000	$13,231,000	$11,076,000	$1,684,000
O&M Cost Present Value	$6,470,000	$1,854,000	$2,150,000	$1,902,000	$1,948,000	$775,000
Total Present Value	$11,768,000	$10,334,000	$12,847,000	$15,133,000	$13,024,000	$2,458,225
Capital Cost per household	$6,000	$9,603	$12,115	$14,984	$12,544	$12,836[1]
Capital Cost to Homeowner with 55% Grant Funding	$6,000	$4,321	$5,451	$6,743	$5,645	$5,776[1]
Estimated O&M Cost Per	$49	$13.33	$16.25	$14.42	$14.75	$25.77

Table 10						
Comparison of the Estimated Costs for the Cold Springs Collection/Conversion Alternatives						
Item	**Denitrifying Septics**	**Vacuum System**	**Grinder Pump**	**Gravity Two Lift**	**Gravity Four Lift**	**School & Whipporwill**
Month per ERU						

NOTE:

[1] The figure presented is only for the residences with gravity access to the Whippoorwill/Puffin sewer line, it does not include the school connection costs.

Section 6: Groundwater Quality

6.1 Hydrogeological Evaluation

A groundwater model was developed for the conversion/collection alternative analysis. The groundwater modeling work was performed by Broadbent and Associates as subconsultant to Kennedy/Jenks. A report dated July 2002 of the hydrogeological analysis was prepared to detail the results the groundwater modeling.

The hydrogeological analysis analyzed various alternatives of standard septic system conversion. Alternatives included converting all, approximately half or none of the existing septic systems to a community sewer system or denitrifying septic systems. The analysis also included effluent disposal at the CSWWTP. The results of the analysis indicated that if all of the septic systems were converted to either denitrifying septics or the community sewer system the nitrate concentration in the near surface groundwater would reach near zero levels within 4 years of completing the conversion. If half of the existing septic systems within the facility plan limits were converted to either denitrifying septics or the community sewer system the nitrate concentration in the near surface groundwater would reach 12 mg/L within 20 years and would be continuing in a downward trend. The analysis assumed a very low concentration of nitrate in the effluent of the denitrifying septic systems. Lacking sufficient data the systems were given the benefit of the doubt and assigned the low effluent nitrate concentration. Washoe County is planning a year long study to develop database to more accurately identify nitrate concentration in denitrifying septic tank system effluent.

The groundwater modeling also investigated the impact on groundwater quality by implementing the conversion/collection alternative of converting the Nancy Gomes Elementary School, the dry sewered areas and the residential lots with gravity access to the Whippoorwill/Puffin sewer line. The groundwater model indicated in this alternative that by reducing nitrate pollution source and with dilution from increased effluent from future development disposed at the CSWWTP that a steady downward trend in nitrate concentration in the groundwater will occur. The model indicates as much as 30 to 40 years before the nitrate concentration falls below 10 mg/L.

Section 7: Conversion/Collection Alternatives Analysis

7.1 Evaluation Categories and Their Relative Importance

Each of the five collection/conversion alternatives were ranked according to the following weighted criteria and subcriteria:

1. Total Present Value Cost – 50%

    Capital Cost - 50%
    O & M - 50%

2. Reliability – 35%

    Mechanical Reliability – 30%
    Treatment Reliability– 40%
    Structural Reliability – 15%
    Future Regulatory Compliance – 15%

3. Pollutant Source Reduction – 15%

4. Impact – 15%

    Disturbance to Residents – 65%
    Ease of O & M – 35%

The rationale behind the scores assigned is provided in the following paragraphs.

7.2 Scores Assigned to Each Alternative

Table 11 gives the rankings determined for each alternative based on the specified criteria. A scale of 0-10 was used, 0 ranking the worst and 10 ranking the best.

Criteria	Sub-Criteria	Weight	Alt. 1 Denit. Septic Tank	Alt. 2 Vacuum System	Alt. 3 Grinder Pump	Alt. 4 Gravity/ 2-Lift	Alt. 5 Gravity/ 4-Lift	Alt. 6 School/Dry Sewers
Cost		**50%**						
	Capital	(50%)	8	5	3	1	2	10
	O & M	(50%)	1	9	9	9	8	10
Reliability		**25%**						
	Mechanical	(30%)	4	7	6	9	8	10
	Treatment	(40%)	5	10	10	10	10	10
	Structural	(15%)	3	8	6	8	8	9
	Future Reg Compliance	(15%)	0	10	10	10	10	10
Pollutant Source Reduction		**15%**	6	10	8	9	9	3
	None							
Impact		**10%**						
	Disturbance to Residents	(65%)	7	5	5	3	3	8
	Ease of O&M	(35%)	0	9	8	4	3	9

Table 11

Collection/Conversion Alternative Evaluation Criteria and Subcriteria Weight and Scores Assigned to Each Alternative

The scores for cost, both capital and O&M, were determined by developing a linear model between the lowest cost (the highest score of 10) and the highest cost (the lowest score of 0). The remaining costs were then scored accordingly. For capital costs Alternative 6 receives the highest score of 10 because of the very low capital cost. The gravity two lift alternative received the lowest score of 1 because it has the highest capital cost.

Because there was such a large margin between the highest (Alternative 1) O&M cost and the lowest (Alternative 6), Alternatives 2, 3, and 4 received equal scores of 9. Therefore, for O&M costs, the denitrifying septic tanks scored a 1 and Alternative 6 received a score of 10. Because of a slightly higher O&M cost, Alternative 5 received a score of 8.

Reliability was broken down into mechanical reliability, treatment reliability, structural reliability (related to probability of leaking), and ability to meet future regulatory compliance. For mechanical reliability, gravity/2-lift and 4-lift stations were given high scores, due to their proven technologies and history of construction. The 4-lift station would have more pumps, so scored slightly lower with an 8. The vacuum system alternative is a proven technology, but newer and more complex than the gravity-lift station configuration. Vacuum sewer lines are also located closer to the ground surface, having a greater chance to be struck by digging, so they scored lower and was assigned a 7. The grinder pump alternative is similar in history to the vacuum system, but has more parts (a pump at every home), so has more chance of mechanical failure, so scored a point below the vacuum system and received a score of 6. The denitrifying septic tanks would convert or use existing septic tanks as part of their system. Considering that some of these septic tanks are approaching 30 years old, their conversion may be impractical. In addition, the denitrifying tanks have a history of pump replacements about every five years, so they scored the lowest under mechanical reliability with a 4. Alternative 6 was given the highest score of 10 because of the relative size of the alternative with very little reliance on mechanical systems other than the Woodland Village Lift Station.

Treatment reliability was analyzed next. Alternatives 2 through 6 would collect sewage and transport it to the CSWWTP for treatment, therefore ranking the highest at 10. The CSWWTP uses Sequencing Batch Reactors (SBRs) as its primary treatment, and effluent nitrate concentrations are measured over the lifetime of the plant at below 0.02 mg/L, consistently meeting the 10 mg/L effluent requirement set by NDEP. However, the denitrifying septic tanks are a newer technology, and have not consistently met nitrate effluent requirements. Letting a score of 0 correspond to the current groundwater nitrate level of approximately 20 mg/L, essentially a "do nothing" score, and assuming the denitrifying septic tanks could maintain a nitrate effluent of 10 mg/L, meeting NDEP effluent requirements (which some vendors claim they can), the denitrifying septic tanks were scored in the middle at 5. Also, if influent levels fluctuate, it can throw the microbial system off. This could happen if the family goes on vacation, has a lot of guests, releases salts from the water softener systems, or perhaps cleans many loads of laundry in one day.

Structural reliability was considered due to sewage leakage being an important parameter in the reliability of the system. The gravity/2-lift, gravity/4-lift and vacuum alternatives all scored an 8. Although not perfect in relation to structural reliability, they are solid systems, without a history of problems. The grinder pump system scored a 6. Because every household would have their own pump, there is a much greater chance of leaking at more locations. The denitrifying septic tanks scored the lowest at 3. Again, converting existing aging tanks would increase their probability of leaking. Alternative 6 received a score of 9.

Meeting future regulatory compliance is important in today's ever-changing world of environmental policy. Alternatives 2 through 6, in which sewage would be treated at the wastewater treatment plant, insures that the collection system will meet future regulations. As regulations change, the treatment plant will have to meet the requirements, but the sewage collection system will not have to change in order to do so. Therefore, Alternatives 2 through 6 scored a 10. The denitrifying septic tanks scored a 0 because if compliance regulations change, the entire system would possibly need to be replaced. The system is not easily modified and is only built to meet today's regulations.

Pollutant source reduction is the primary goal of the conversion of the existing septic systems in the Cold Springs Valley. As an evaluation criterion this was given a weight of 15% and no subcriteria were assigned to the criterion. Alternative 6 was given the lowest score of 3 because this alternative does the least to reduce pollutant source. The vacuum system received the highest score of 10 because the vacuum that exists in the collection system means that the possibility of leakage is almost non-existent. The gravity lift station alternatives received equal scores of 9. These alternatives score high but were scored slightly lower because of the possibility of leaks in the collection system. The grinder pump alternative received a score of 8 because with the pressured sewage conveyance system to the CSWWTP the likely hood of leakage is greater than the gravity system. The denitrifying septic tank alternative was assigned a score of 6 because of operation and maintenance concerns.

The last major criterion identified was impact to the residents. This included disturbance to residents and the ease of future operation and maintenance functions. All alternatives would disturb the individual property owners to some degree. Septic tank conversion would cause the least disturbance so it scored high. It would involve digging and converting the existing septic tanks into denitrifying systems on each property.

The vacuum and grinder pump systems would cause a greater degree of disturbance to the residents of the Cold Springs Valley and scored a 5. These would require constructing laterals from the residence, as well as trench excavation in order to route the piping systems. This might involve road closures, heavy machinery, and lengthy construction periods.

The gravity/2-lift and 4-lift options scored the lowest in the category of disturbance to residents and were given a 3. These would be the most lengthy construction phases, requiring extensive excavation. Again this would involve road closures, heavy machinery, and lengthy construction periods, but to a larger degree. Alternative 6 receives the highest score of 8 because of the small project size.

As far as ease of O&M, it was determined that the vacuum system would be the easiest to maintain. It has the least number of major parts, and only one central vacuum station to maintain. With no direct impact to the resident, it scored highest with a 9. Alternative 6 also received a score of 9. Next, the grinder pump system would be the easiest to operate and maintain. Because there is a pump installed on every property, with electricity being supplied by the homeowner, it scored slightly lower than the vacuum system. The gravity/2-lift and 4-lift stations would require more routine maintenance than the vacuum or grinder pump systems, and scored lower accordingly. Also, if any maintenance were to be required on the pipes, at a depth of up to 20 feet, this would be time consuming and excavation may be required. Lastly, the denitrifying septic systems scored the lowest on ease of O&M. These systems would require the most maintenance, and therefore scored a 0 in this subcriteria. Monthly sampling would be required, meaning technicians would be on the property monthly. In addition, detailed logs would need to be kept and costly laboratory testing performed to insure the tanks are working properly.

7.3 Ranking of Alternatives

Once the scores were established, the scores were input into a computer model, where a hierarchy of the evaluation criteria had been built. The decision score for each alternative is the sum of the score (rating) of that alternative with respect to each of the lowest criteria weighted by how important each individual criterion is in the model. The higher the decision score of the alternative, the closer that alternative comes to meeting all the criteria in the decision. The computer model rates the alternatives from least to most appealing on a normalized scale of 0-1. Table 12 and Figure 10 give the ranking for each conversion/collection system alternative. The conversion of the school and the dry sewered lots was identified as the most favorable alternative followed by the vacuum system alternative.

Table 12 Ranking of Collection/Conversion Alternatives	
Denitrifying Septic Tanks:	0.452
Vacuum Systems:	0.784
Grinder Pumps:	0.686
Gravity/2-Lift:	0.654
Gravity/4-Lift:	0.643
School/Dry Sewer/Gravity Access Lots	0.875

Figure 10 provides a graphical presentation of how each alternative ranked.

The computer model also performs a sensitivity analysis of the data. This analysis shows the sensitivity of the preferred alternative to changes in the criterion weights, or ratings values. In this way, you can see what the preferred alternative would be if for example, money was no concern. Figure 11 shows the sensitivity of all the alternatives relative to capital cost and Figure 12 shows the sensitivity relative to O&M costs.

If each of these collection/conversion system alternatives were broken down into $2 million/year projects, each would take approximately the same amount of time to complete. On the low end, the vacuum system alternative would take approximately 6 years to complete. On the high end, the gravity/2-lift collection system would take approximately 9 years to complete.

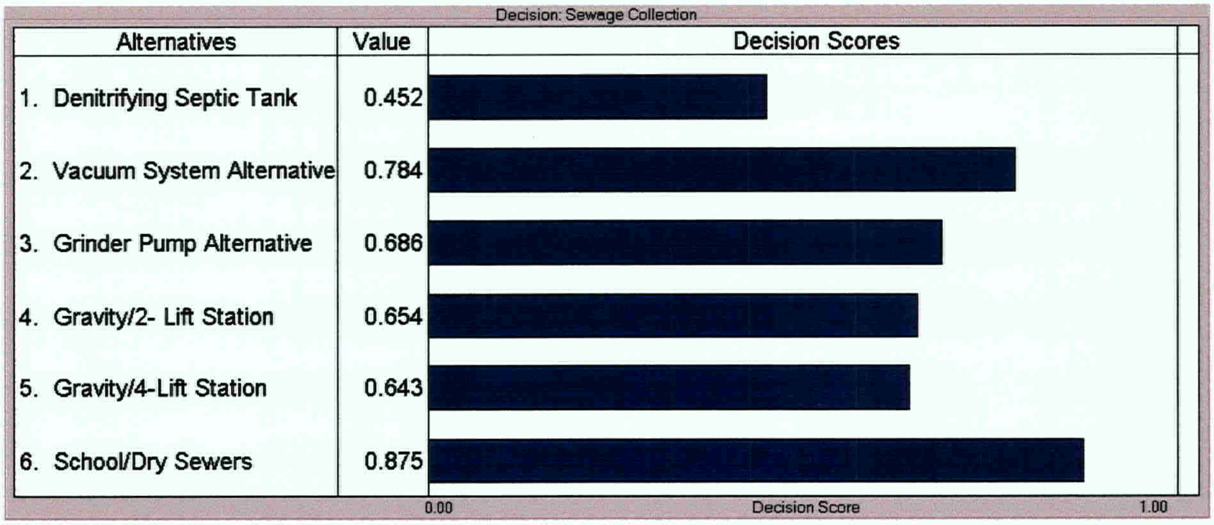

Figure 10. Collection/Conversion System Alternatives Ranking

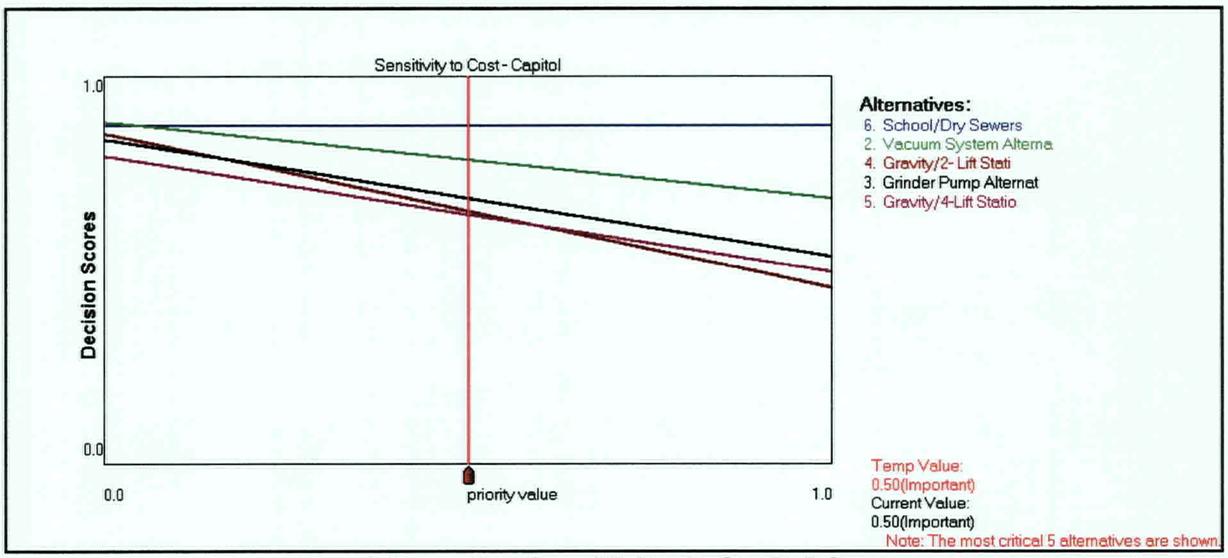

Figure 11. Sensitivity to Capital Cost

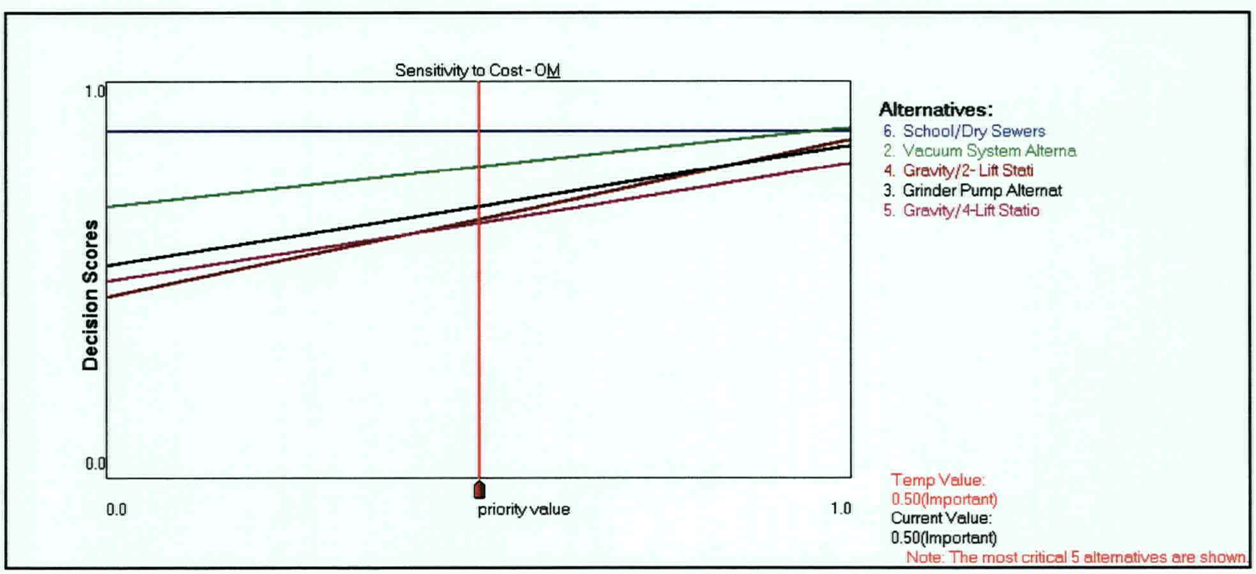

Figure 12. Sensitivity to O&M Costs

Section 8: Conclusion, Recommendation And Phasing Plan

8.1 Recommendation

It is recommended that the conversion/collection alternative of converting the Nancy Gomes Elementary School, dry sewer area #2, and the residential lots with gravity access to the Whippoorwill/Puffin sewer line to the community wastewater system be pursued. This alternative has by far the least cost. The main disadvantage of this alternative is that a long time is required to reduce near surface groundwater nitrate concentrations below 10 mg/L. The hydrogeological analysis indicates by implementing this alternative a steady decrease in nitrate concentration will be realized. The decrease is partly the result of reducing pollutant source albeit by a small fraction compared to the other alternatives. However, the primary cause for groundwater quality improvement will result from future development by Lifestyle/Woodland Homes. The additional flows treated at the CSWWTP with effluent disposed in rapid infiltration beds will result in dilution of the near surface groundwater.

It is recommended to implement the recommended alternative in Phases 1A, 1B, and 1C and if necessary a second phase which would implement the conversion of all septic systems within the facility plan limits to the community wastewater system. If groundwater monitoring verifies the predictions of the groundwater model then only the first phase need be implemented. The groundwater model indicates that eventually the nitrate concentrations in the near surface groundwater will fall below a value of 10 mg/l. If after implementation of the first phase the groundwater monitoring results do not follow as the groundwater model predicts then the second phase can be implemented. The phased implementation is described in the following subsections.

8.2 Phase One Improvements

Phase One improvements are divided in the following three sub-phases.

- Phase 1A – Convert the Nancy Gomes Elementary School to the community wastewater system.
- Phase 1B – Convert all the residences in dry sewer area #2 to the community wastewater system.
- Phase 1C – Convert the residential lots with gravity access to the Whippoorwill/Puffin sewer line to the community wastewater system.

If after implementation of these three sub phases that groundwater quality improvement is not realized then the second phase can be implemented. Once Phases 1A, 1B and 1C are completed it is recommended that 5 to 8 years of groundwater monitoring occur to see if the downward trend in groundwater nitrate concentration as predicted by the groundwater model is observed. If a downward trend is observed, then a decision is required by policy makers to continue observation and demonstrate the patience required to reach a nitrate concentration less than 10 mg/L. Alternatively, if funding and political will exists, Washoe County may choose to implement the second phase. The proposed Phase Two improvements are detailed in the following section.

8.3 Phase Two Improvements

Phase 2 improvements would be implemented under one of the three following conditions.

1. If Phase 1 improvements fail to realize an improvement in groundwater quality.
2. If chosen by the leaders of Washoe County to expedite groundwater remediation.
3. If required by the State of Nevada Division of Environmental Protection

It is recommended that if Phase 2 is implemented the conversion/collection alternative using a vacuum collection system be the alternative implemented. This alternative provides the lowest cost of converting the existing septic systems. This alternative is favorable for a number of reasons including the following.

1. The CSWWTP is located at a higher elevation than the area with existing septic tanks and gravity flow is not possible to the treatment plant. The area of the existing septics is relatively flat and conducive for a vacuum system installation. A gravity collection system using lift stations requires some very deep pipeline invert elevations to maintain adequate velocity in the sewer lines.
2. The groundwater in a large portion of the area with existing septic tanks is very near the surface. The vacuum sewer system does not rely on gravity flow and thus the sewer mains need not be installed at a great depth.
3. The area with existing septic systems is very nearly built out. The gravity/lift station alternatives require pipeline installations to a depth of up to 24 feet below the ground surface. Construction of these lines in an existing street will be costly and extremely disruptive to the residences.
4. Emergency power supply can be provided to provide continued operation during power outages. The grinder pump alternative does not include emergency power supply at each pump installation site.
5. Since the vacuum system is under vacuum the occurrence of leakage is minimized. The grinder pump system operates under low pressure and the possibility exists that leaks could occur resulting in raw sewage introduction into the environment.
6. Vacuum sewer systems have been used successfully in the United States for decades. They have few moving parts compared to a grinder pump system. With the vacuum station and the associated pump station to convey flow via a force main to the CSWWTP the level of complexity is comparable to a gravity/lift station configuration.

The vacuum system lends itself to phased implementation so infrastructure improvements can be made as funding becomes available.

The phased implementation of the vacuum system would include establishing service zones. The first phase would include installation of the central vacuum station and the associated pump station and force main to convey flows to the CSWWTP. If subsequent years additional zone could be constructed.

If Phase Two is implemented then a second expansion of the Cold Springs Wastewater Treatment Plant will be required. A second phase expansion would increase the total treatment capacity to 1.25 MGD. The capacity and timing of the expansion is affected by factors that should be revisited in the future when the first plant expansion nears its capacity. The actual development density and flows per household should be examined at that time.

References

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4. United States Environmental Protection Agency. Alternative Wastewater Collection Systems. October 1991.

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6. Kennedy/Jenks Consultants, Technical Memorandum No. 1, Introduction and Existing Conditions.

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8. Kennedy/Jenks Consultants, Technical Memorandum No. 3, Effluent Disposal Alternatives and Their Impact on Cold Springs Groundwater.

9. Kennedy/Jenks Consultants, Cold Springs Wastewater Facility Plan.

10. AIRVAC Vacuum Collection Systems, Technical Report Cold Springs, NV, January 2002.

11. E/One Sewer Systems, www.eone.com, March 2002.

Appendix

Vacuum System Alternative
Capitol Costs
Cold Springs, NV

Installed Cost-Collection System

Quanity	Description	Unit Price	Total Price
6250 lf	10" Vacuum Sewer	55.00 /lf	343,750
4500 lf	8" Vacuum Sewer	45.00 /lf	202,500
9600 lf	6" Vacuum Sewer	35.00 /lf	336,000
37900 lf	4" Vacuum Sewer	25.00 /lf	947,500
442 ea	Crossover Connections	400.00 /ea	176,800
3 ea	10" Division Valve	1500.00 /ea	4,500
5 ea	8" Division Valve	1250.00 /ea	6,250
11 ea	6" Division Valve	1000.00 /ea	11,000
40 ea	4" Division Valve	800.00 /ea	32,000
441 ea	AIRVAC Valve Pits	3200.00 /ea	1,411,200
1 ea	Dual Buffer Tanks	4500.00 /ea	4,500
1 set	Special Tools	3000.00 /set	3,000
3%	Spare Parts		42,300
1 ea	Portable Vacuum Pump	16,000.00 /ea	16,000
10000 lf	8 Force Main	15.00 /lf	150,000

Collection System Cost **$3,687,300**

Installed Cost-Vacuum Station

Equipment	185,000
Equipment Installation	43,000
Station Wiring, Piping, Etc	25,000
Motor-generator set	35,000
Building	100,000
Adjustment (odor Control)	15,000

Vacuum Station Cost **$403,000**

Total Installed Cost	**$4,090,300**
# EDU's	932
Cost Per EDU	**$4,389**

Vacuum Collection System
O M Costs
Cold Springs, NV

Estimated O&M Costs

# Connections	883
# EDU's	932
Estimated Collection System Cost:	$3,687,300
Estimated Vacuum Station Cost:	$403,000
Total Estimated Cost:	$4,090,300
Annual O & M Cost:	**$46,300 /yr**

Cold Springs Wastewater Facility Plan
Grinder Pump Option
Cost Estimate

Item	Units	Quantity	Unit Price	Extension
Clean out assemblies for low pressure mains	each	75	400	$30,000
Pump/Control Panel/Lateral Kits Materials Costs (includes grinder pump, wet pit, fittings for lateral to main, curb stop, check valve, etc.)	each	951	2500	$2,377,500
Pump / Control Panel / Lateral Kit Installation	each	951	800	$760,800
House connection to Grinder Pump (4")	each	951	400	$380,400
Power supply from house to pump includes materials and installation	each	951	450	$427,950
1.25" diameter lateral from grinder pump to main	feet	47550	15	$713,250
1.5" low pressure main materials and installation	feet	8800	8	$70,400
2" low pressure main materials and installation	feet	23385	9	$210,465
3" low pressure main materials and installation	feet	22270	10	$222,700
4" low pressure main materials and installation	feet	6900	12	$82,800
6" low pressure main materials and installation	feet	2920	18	$52,560
8" low pressure main materials and installation	feet	6500	24	$156,000
Subtotal				$5,484,825
Contingency (15%)				$822,724
Total Cost				**$6,307,549**
Total cost per home				**$6,633**
Does not include the following costs:				
(1) costs to increase WWTP capacity				
(2) Septic abandonment				
(3) County hook-up fee				
Assumptions:				
(1) low pressure main installation outside of edge of pavement				
(2) power supply from house constructed in the same trench as the sewer lateral				

Cold Springs Wastewater Facility Plan
Grinder Pump Option
Operation and Maintenance Costs

Electrical								
	Pump (HP)	Pump (kW)	Hours of Operation (per day)	Pump kW-hr (per day)	Power Cost ($/kW-hr)	Power Cost Per day	Power Cost per Month	Power Cost per Year
Grinder Pump Electrical	1	0.746	0.75	0.5595	0.1	$0.06	$1.68	$20.42
Parts Replacement	Replacment Cost ($)			Useful Life (years)	Cost Per Year ($)		Cost per month ($)	
Stator	100			10	$10.00		$0.83	
Mechanical Seal	150			10	$15.00		$1.25	
Impellers	300			10	$30.00		$2.50	
Subtotal							$4.58	
Summarized O&M Cost	Monthly Cost per Unit							
Electrical	$1.68							
Replacment	$4.58							
Total	**$6.26**							
Does NOT include the following costs:								
(1) County fees for sewage treatment								
(2) Low pressure sewer main repairs								

2-Lift Station Cost Estimate

Item	Quantity	Units	Unit cost	Total
8" Gravity sewer, typical	56500	LF	$120.00	$6,780,000
8" gravity sewer, with dewatering	4500	LF	$150.00	$675,000
Lift station, 20 ft sewer invert	1	ea.	$500,000.00	$500,000
Lift station, 17 ft sewer invert	1	ea.	$475,000.00	$475,000
8" PVC Force Main	11750	LF	$35.00	$411,250
				$8,841,250

4-Lift Station Cost Estimate

Item	Quantity	Units	Unit cost	Total
8" Gravity sewer, typical	22530	LF	$50.00	$1,126,500
8" Gravity sewer with shoring	26350	LF	$100.00	$2,635,000
8" gravity sewer - shore and dewater	4960	LF	$150.00	$744,000
Lift station, 8.5 ft sewer invert	1	ea.	$375,000.00	$375,000
Lift station, 12 ft sewer invert	1	ea.	$400,000.00	$400,000
Lift station, 14 ft sewer invert	1	ea.	$420,000.00	$420,000
Lift station, 16 ft sewer invert	1	ea.	$450,000.00	$450,000
8" PVC Force Main	11750	LF	$45.62	$536,035
				$6,686,535

Force Main

Item	**Quantity**	**Units**	**Unit cost**	**Total Cost**	**Cost per LF**
8" Force Main	11750	LF	$12.00	$141,000.00	
Trench shoring		Sq. Ft		$0.00	$50.72
Trench excavation	6000	cu. Yd.	$5.10	$30,600.00	
pipe bedding material	2325	cu. Yd.	$15.25	$35,500.00	
Screened Backfill	2611	cu. Yd.	$26.80	$70,000.00	
Road Patch	6900	sq. Yd.	$30.00	$207,000.00	
export of trench spoils	1100	cu. Yd.	$10.00	$11,000.00	
			Sub-Total	$496,000.00	
			20% contingency	$100,000.00	
			Total	$596,000.00	

Typical Section Cost

Item	Quantity	Units	Unit cost	Total Cost
8" sewer main	500	LF	$7.75	$3,900.00
4" lateral	300	LF	$4.14	$1,300.00
8x4 wye	12	ea	$100.00	$1,200.00
Trench shoring		sq ft	$7.80	$0.00
Trench excavation	425	cu. Yd.	$5.10	$2,200.00
Pipe bedding material	150	cu. Yd.	$25.00	$3,800.00
Screened Backfill	125	cu. Yd.	$10.00	$1,300.00
Road Patch	365	sq. Yd.	$30.00	$11,000.00
Export of trench spoils	192	cu. Yd.	$10.00	$2,000.00
Manholes	3	ea	$3,000.00	$9,000.00
			Sub-Total	$35,700.00
			20% contingency	$7,140.00
			Total	$42,840.00

Cost per LF of sewer main
$86.00

Trenches to 6'
Assumes no shoring or de-watering necessary

Deep Section Without Dewatering

Item	Quantity	Units	Unit cost	Total Cost
8" sewer main	500	LF	$7.75	$3,900.00
4" lateral	360	LF	$4.14	$1,500.00
8x4 wye	12	ea	$100.00	$1,200.00
Trench Dewatering	0	days	$150.00	$0.00
Trench shoring	10000	sq. ft	$0.00	$0.00
Trench excavation	615	cu. Yd.	$2.00	$1,300.00
Pipe bedding material	150	cu. Yd.	$25.00	$3,800.00
Screened Backfill	350	cu. Yd.	$10.00	$3,500.00
Road Patch	365	sq. Yd.	$30.00	$11,000.00
Export of trench spoils	192	cu. Yd.	$10.00	$2,000.00
Manholes	3	ea	$3,000.00	$9,000.00
			Sub-Total	$38,000.00
			20% contingency	$7,600.00
			Total	$46,000.00

Cost per LF of sewer main
$92.00

Trench 6-12 feet deep but does not require dewatering
Assumes completion of 500 LF in 3 - 8 hr workdays-166 ft/day

Deep Section with Dewatering

Item	Quantity	Units	Unit cost	Total Cost
8" sewer main	500	LF	$7.75	$3,900.00
4" lateral	360	LF	$4.14	$1,500.00
8x4 wye	12	ea	$25.00	$300.00
Trench Dewatering	3	days	$150.00	$450.00
Trench shoring	14000	sq. ft	$8.90	$125,000.00
Trench excavation	695	cu. Yd.	$5.10	$3,600.00
pipe bedding material	146.5	cu. Yd.	$15.25	$2,300.00
Screened Backfill	550	cu. Yd.	$26.80	$14,800.00
Road Patch	365	sq. Yd.	$30.00	$11,000.00
export of trench spoils	192	cu. Yd.	$10.00	$2,000.00
Manholes	2	ea	$3,000.00	$6,000.00
			Sub-Total	$171,000.00
			20% contingency	$34,200.00
			Total	$206,000.00

Cost per LF of sewer main
$420.00

Trench >12 feet deep, requiring de-watering
Assumes completion of 500 LF in 3 - 8 hr workdays-166 ft/day

Cost per LF of sewer main
420

COLD SPRINGS SEWER DESIGN

Min Cover =	4.67
Pipe Dia. =	0.67
Std. Slope =	0.006
n =	0.014

4-LIFT STATION

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES	
YELLOW 1	5,066.25	5,064.90	521.82	0.006	3.13	-	5,061.58	5,058.45	7.11	2.50	12	12	1	3712.36
YELLOW 2	5,064.90	5,064.80	474.31	0.006	2.85	0.10	5,058.35	5,055.51	9.29	2.50	9	21	1	4407.975
YELLOW 3	5,065.00	5,064.80	251.44	0.006	1.51	0.10	5,060.34	5,058.83	5.97	2.50	7	7		1500.755
YELLOW 4	5,064.80	5,067.00	486.29	0.006	2.92	0.10	5,055.41	5,052.49	14.51	2.50	8	36	1	7054.969
YELLOW 5	5,067.00	5,055.00	1,233.40	0.006	7.40	0.10	5,052.39	5,044.99	10.01	2.50	24	60	3	12344.04
YELLOW 6	5,055.00	5,053.00	232.17	0.006	1.39	0.10	5,044.89	5,043.50	9.50	2.50	4	64		2205.884
YELLOW 7	5,066.00	5,064.90	401.74	0.006	2.41	0.10	5,061.34	5,058.93	5.97	2.50	9	9		2398.565
YELLOW 8	5,064.90	5,064.80	324.51	0.006	1.95	0.10	5,058.83	5,056.88	7.92	2.50	6	15		2569.308
YELLOW 9	5,064.80	5,065.20	261.67	0.006	1.57	0.10	5,056.78	5,055.21	9.99	2.50	5	20		2613.434
YELLOW 10	5,065.20	5,061.80	702.85	0.006	4.22	0.10	5,055.11	5,050.90	10.90	2.50	14	34	1	7664.312
YELLOW 11	5,061.80	5,060.62	163.81	0.006	0.98	0.10	5,050.80	5,049.81	10.81	2.50	2	36		1770.373
YELLOW 12	5,059.00	5,060.62	145.90	0.006	0.88	0.10	5,049.71	5,048.84	11.78	2.50	4	4		1719.122
YELLOW 13	5,060.62	5,060.10	345.28	0.006	2.07	0.10	5,048.74	5,046.67	13.43	2.50	4	44		4638.685
YELLOW 14	5,064.90	5,062.50	269.97	0.006	1.62	0.10	5,059.46	5,057.84	4.66	2.50	7	7		1258.012
YELLOW 15	5,062.50	5,062.30	174.31	0.006	1.05	0.10	5,057.74	5,056.69	5.61	2.50	3	10		977.1261
YELLOW 16	5,062.30	5,062.20	187.23	0.006	1.12	0.10	5,056.59	5,055.47	6.73	2.50	2	12		1259.882
YELLOW 17	5,062.50	5,062.20	178.24	0.006	1.07	0.10	5,057.84	5,056.77	5.43	2.50	5	5		967.7434
YELLOW 18	5,062.20	5,062.00	308.97	0.006	1.85	0.10	5,056.15	5,054.30	7.70	2.50	4	21		2380.249
YELLOW 19	5,062.00	5,061.25	296.21	0.006	1.78	0.10	5,054.20	5,052.42	8.83	2.50	5	26		2615.854
YELLOW 20	5,067.00	5,064.80	992.10	0.006	5.95	0.10	5,062.34	5,056.39	8.41	2.50	19	19	3	8346.14
YELLOW 21	5,064.80	5,061.25	681.37	0.006	4.09	0.10	5,056.29	5,052.20	9.05	2.50	12	31	1	6166.957
YELLOW 22	5,061.25	5,060.10	315.32	0.006	1.89	0.10	5,052.10	5,050.21	9.89	2.50	2	59		3119.379
YELLOW 23	5,060.20	5,060.00	260.58	0.006	1.56	0.10	5,055.54	5,053.98	6.02	2.50	6	6		1569.598
YELLOW 24	5,060.00	5,060.10	309.83	0.006	1.86	0.10	5,053.88	5,052.02	8.08	2.50	4	10		2504.189
YELLOW 25	5,060.10	5,055.00	371.76	0.006	2.23	0.10	5,046.57	5,044.34	10.66	2.50	2	115		3963.17
YELLOW 26	5,060.00	5,057.00	171.39	0.006	1.03	0.10	5,053.37	5,052.34	4.66	2.50	4	4		798.3929
YELLOW 27	5,057.00	5,055.50	142.62	0.006	0.86	0.10	5,051.69	5,050.83	4.67	2.50	3	7		665.425
YELLOW 28	5,055.50	5,055.00	635.14	0.006	3.81	0.10	5,050.73	5,046.92	8.08	2.50	9	16	1	5129.746
YELLOW 29	5,055.00	5,053.50	204.29	0.006	1.23	0.10	5,045.24	5,044.01	9.49	2.50	2	133		1937.842
YELLOW 30	5,053.50	5,053.00	256.45	0.006	1.54	0.10	5,043.91	5,042.38	10.62	2.50	5	138		2724.638
YELLOW 31	5,053.00	5,050.50	184.71	0.006	1.11	0.10	5,042.28	5,041.17	9.33	2.50	1	203		1723.843
YELLOW 32	5,050.50	5,047.50	213.25	0.006	1.28	0.10	5,041.07	5,039.79	7.71	2.50	3	206		1644.627
YELLOW 33	5,051.25	5,049.00	806.3	0.006	4.84	0.10	5,046.59	5,041.75	7.25	2.50	15	15	1	5843.901
YELLOW 34	5,049.00	5,047.50	522.11	0.006	3.13	0.10	5,041.65	5,038.52	8.98	2.50	6	21	1	4688.788
YELLOW 35	5,043.00	5,047.50	320.11	0.006	1.92	0.10	5,038.34	5,036.42	11.08	2.50	7	7		3547.03
YELLOW 36	5,047.50	5,047.50	200.43	0.006	1.20	0.10	5,036.32	5,035.12	12.38	2.50	0	234		2481.973
														0
									312.53		234			
														0

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES	
BLUE 1	5,069.00	5,065.00	1,478.85	0.006	8.87	0.10	5,064.34	5,055.47	9.53	2.50	27	27	4	14098.02
BLUE 2	5,065.00	5,063.50	331.36	0.006	1.99	0.10	5,055.37	5,053.38	10.12	2.50	5	32		3353.781
BLUE 3	5,061.50	5,063.50	425.91	0.006	2.56	0.10	5,056.84	5,054.28	9.22	2.50	8	8	1	3924.957
BLUE 4	5,069.50	5,063.50	1,541.62	0.006	9.25	0.10	5,064.84	5,055.59	7.91	2.50	25	25	4	12193.78
BLUE 5	5,063.50	5,061.00	450.85	0.006	2.71	0.10	5,053.28	5,050.57	10.43	2.50	2	67	1	4700.156
BLUE 6	5,064.00	5,060.00	129.00	0.006	0.77	0.10	5,059.34	5,054.81	5.19	2.50	2	2		669.51
BLUE 7	5,061.25	5,060.00	280.19	0.006	1.68	0.10	5,056.59	5,054.91	5.09	2.50	7	7		1426.487
BLUE 8	5,060.00	5,059.90	352.65	0.006	2.12	0.10	5,054.81	5,052.69	7.21	2.50	4	13		2541.563
BLUE 9	5,060.10	5,059.90	181.58	0.006	1.09	0.10	5,050.47	5,049.38	10.52	2.50	6	6		1910.127
BLUE 10	5,059.90	5,061.00	205.60	0.006	1.23	0.10	5,049.28	5,048.05	12.95	2.50	1	20		2663.153
BLUE 11	5,061.00	5,060.00	168.18	0.006	1.01	0.10	5,047.95	5,046.94	13.06	2.50	2	89		2196.794
BLUE 12	5,060.00	5,056.50	200.06	0.006	1.20	0.10	5,046.84	5,045.64	10.86	2.50	1	90		2173.156
BLUE 13	5,055.00	5,056.50	373.63	0.006	2.24	0.10	5,050.34	5,048.10	8.40	2.50	8	8		3139.157
BLUE 14	5,056.50	5,051.25	361.34	0.006	2.17	0.10	5,048.00	5,045.83	5.42	2.50	2	100		1958.398
BLUE 15	5,050.00	5,051.25	379.52	0.006	2.28	0.10	5,045.34	5,043.06	8.19	2.50	8	8		3107.176
BLUE 16	5,051.25	5,047.80	360.15	0.006	2.16	0.10	5,042.96	5,040.80	7.00	2.50	3	111		2520.337
BLUE 17	5,052.50	5,047.80	379.59	0.006	2.28	0.10	5,047.84	5,040.90	6.90	2.50	8	8		2619.171
BLUE 18	5,047.80	5,045.00	385.34	0.006	2.31	0.10	5,040.80	5,038.49	6.51	2.50	3	122		2509.349
BLUE 19	5,047.00	5,045.00	206.12	0.006	1.24	0.10	5,042.34	5,038.59	6.41	2.50	7	7		1321.229
BLUE 20	5,043.00	5,043.00	328.78	0.006	1.97	0.10	5,038.34	5,036.37	6.63	2.50	6	6		2180.693
BLUE 21	5,045.60	5,043.00	131.37	0.006	0.79	0.10	5,040.94	5,036.47	6.53	2.50	4	4		857.8461
BLUE 22	5,043.00	5,043.10	304.13	0.006	1.82	0.10	5,036.37	5,034.55	8.55	2.50	3	13		2601.765
BLUE 23	5,046.25	5,043.10	243.83	0.006	1.46	0.10	5,039.56	5,038.10	5.00	2.50	6	6		1219.877
BLUE 24	5,043.10	5,043.00	303.53	0.006	1.82	0.10	5,034.45	5,032.63	10.37	2.50	4	23		3147.964
BLUE 25	5,043.00	5,045.00	279.10	0.006	1.67	0.10	5,032.53	5,030.85	14.15	2.50	4	27		3948.087
BLUE 26	5,045.00	5,041.30	435.82	0.006	2.61	0.10	5,030.75	5,028.14	13.16	2.50	1	157	1	5735.391
BLUE 27	5,043.70	5,041.30	339.99	0.006	2.04	0.10	5,038.20	5,036.16	5.14	2.50	4	4		1747.528
BLUE 28	5,041.30	5,040.80	88.01	0.006	0.53	0.10	5,028.04	5,027.51	13.29	2.50	0	161		1169.482
														0
									243.74		161			0
														0
GREEN 1	5,071.20	5,070.60	376.48	0.006	2.26	0.10	5,066.54	5,064.28	6.32	2.50	6	6		2378.932
GREEN 2	5,071.80	5,070.60	162.90	0.006	0.98	0.10	5,066.14	5,065.16	5.44	2.50	4	4		885.7525
GREEN 3	5,070.60	5,070.00	485.89	0.006	2.92	0.10	5,064.18	5,061.26	8.74	2.50	2	12	1	4244.414
GREEN 4	5,072.90	5,072.50	172.20	0.006	1.03	0.10	5,068.24	5,067.21	5.29	2.50	6	6		911.489
GREEN 5	5,073.10	5,072.50	84.42	0.006	0.51	0.10	5,068.44	5,067.31	5.19	2.50	2	2		438.1398
GREEN 6	5,072.50	5,070.00	372.10	0.006	2.23	0.10	5,067.21	5,064.98	5.02	2.50	4	12		1868.909
GREEN 7	5,070.00	5,075.00	357.11	0.006	2.14	0.10	5,061.16	5,059.02	15.98	2.50	0	24		5707.568
GREEN 8	5,072.50	5,075.00	149.37	0.006	0.90	0.10	5,067.84	5,066.94	8.06	2.50	4	4		1203.358
GREEN 9	5,078.00	5,077.50	185.79	0.006	1.11	0.10	5,073.34	5,072.23	5.27	2.50	3	3		979.9939
GREEN 10	5,076.90	5,077.50	140.66	0.006	0.84	0.10	5,072.24	5,071.40	6.10	2.50	5	5		858.583
GREEN 11	5,077.50	5,076.00	321.18	0.006	1.93	0.10	5,072.13	5,070.20	5.80	2.50	5	13		1861.906
GREEN 12	5,076.00	5,075.00	385.50	0.006	2.31	0.10	5,070.10	5,067.79	7.21	2.50	7	20		2779.486
GREEN 13	5,075.00	5,072.00	341.38	0.006	2.05	0.10	5,058.92	5,056.87	15.13	2.50	0	48		5164.492
GREEN 14	5,071.25	5,073.80	317.88	0.006	1.91	0.10	5,066.59	5,064.68	9.12	2.50	10	10		2898.201
GREEN 15	5,073.80	5,072.50	508.52	0.006	3.05	0.10	5,064.58	5,061.53	10.97	2.50	6	17	1	5577.651
GREEN 16	5,072.50	5,072.00	265.96	0.006	1.60	0.10	5,061.43	5,059.84	12.16	2.50	5	22		3235.18
GREEN 17	5,072.00	5,069.00	265.95	0.006	1.60	0.10	5,056.77	5,055.17	13.83	2.50	6	76		3676.945

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES	
GREEN 18	5,069.00	5,065.80	168.98	0.006	1.01	0.10	5,055.07	5,054.06	11.74	2.50	3	79		1983.754
GREEN 19	5,065.80	5,060.80	241.24	0.006	1.45	0.10	5,053.96	5,052.51	8.29	2.50	1	80		1999.161
GREEN 20	5,060.80	5,056.30	859.27	0.006	5.16	0.10	5,052.41	5,047.26	9.04	2.50	15	95	2	7770.069
GREEN 21	5,063.00	5,067.00	724.96	0.006	4.35	0.10	5,058.34	5,053.99	13.01	2.50	7	7	1	9431.556
GREEN 22	5,071.25	5,070.90	218.10	0.006	1.31	0.10	5,066.59	5,065.28	5.62	2.50	4	4		1225.417
GREEN 23	5,070.00	5,070.90	180.10	0.006	1.08	0.10	5,065.34	5,064.26	6.64	2.50	6	6		1195.972
GREEN 24	5,070.90	5,067.00	229.73	0.006	1.38	0.10	5,063.72	5,053.89	13.11	2.50	1	11		3011.76
GREEN 25	5,067.00	5,063.80	147.89	0.006	0.89	0.10	5,053.79	5,053.89	9.91	2.50	0	18		1465.59
GREEN 26	5,063.00	5,063.80	133.35	0.006	0.80	0.10	5,058.34	5,057.54	6.26	2.50	4	4		834.7843
GREEN 27	5,063.80	5,050.00	268.71	0.006	1.61	0.10	5,046.95	5,045.34	4.66	2.50	3	25		1252.796
GREEN 28	5,050.00	5,056.30	394.23	0.006	2.37	0.10	5,053.73	5,051.36	4.94	2.50	4	29		1945.675
GREEN 29	5,056.30	5,055.00	350.37	0.006	2.10	0.10	5,047.16	5,045.06	9.94	2.50	2	126		3483.456
GREEN 30	5,056.25	5,055.00	463.70	0.006	2.78	0.10	5,051.59	5,048.81	6.19	2.50	8	8	1	2871.323
GREEN 31	5,055.00	5,048.80	498.82	0.006	2.99	0.10	5,044.96	5,041.97	6.83	2.50	6	140	1	3408.397
GREEN 32	5,051.20	5,048.75	194.17	0.006	1.17	0.10	5,041.87	5,040.70	8.05	2.50	2	142		1562.669
GREEN 33	5,051.20	5,048.75	224.42	0.006	1.35	0.10	5,045.44	5,044.09	4.66	2.50	6	6		1045.016
GREEN 34	5,048.75	5,048.70	162.51	0.006	0.98	0.10	5,040.60	5,039.62	9.08	2.50	2	150		1474.788
GREEN 35	5,048.70	5,050.20	329.60	0.006	1.98	0.10	5,039.52	5,037.55	12.65	2.50	3	153		4170.317
GREEN 36	5,055.00	5,050.20	465.51	0.006	2.79	0.10	5,048.30	5,045.51	4.69	2.50	10	10	1	2184.666
GREEN 37	5,052.20	5,048.00	234.52	0.006	1.41	0.10	5,037.55	5,036.14	11.86	2.50	4	167		2780.732
GREEN 38	5,048.00	5,046.50	175.86	0.006	1.06	0.10	5,036.04	5,034.99	11.51	2.50	3	170		2024.55
GREEN 39	5,051.25	5,049.00	221.84	0.006	1.33	0.10	5,045.59	5,044.26	4.74	2.50	9	9		1051.752
GREEN 40	5,049.00	5,047.50	192.59	0.006	1.16	0.10	5,044.00	5,042.84	4.66	2.50	1	10		896.6104
GREEN 41	5,051.50	5,050.80	178.60	0.006	1.07	0.10	5,046.84	5,045.77	5.03	2.50	6	6		898.6438
GREEN 42	5,050.80	5,049.00	192.06	0.006	1.15	0.10	5,045.49	5,044.34	4.66	2.50	2	8		895.4529
GREEN 43	5,049.00	5,047.50	520.62	0.006	3.12	0.10	5,044.24	5,041.11	6.39	2.50	0	8	1	3324.721
GREEN 44	5,047.50	5,046.50	452.32	0.006	2.71	0.10	5,041.01	5,038.30	8.20	2.50	0	18	1	3709.024
														0
									357.98					0
														0
RED 1	5,086.50	5,078.10	646.18	0.006	3.88	0.10	5,077.24	5,073.36	4.74	2.50	13	13	1	3061.006
RED 2	5,077.80	5,078.10	90.09	0.006	0.54	0.10	5,073.14	5,072.60	5.50	2.50	2	15		495.5436
RED 3	5,078.10	5,075.60	862.48	0.006	5.17	0.10	5,072.50	5,067.32	8.28	2.50	14	29	2	7137.384
RED 3A	5,075.60	5,071.25	491.60	0.006	2.95	0.10	5,067.22	5,064.27	6.98	2.50	9	38	1	3428.92
RED 4	5,071.25	5,068.75	213.54	0.006	1.28	0.10	5,065.22	5,063.94	4.81	2.50	4	42		1027.392
RED 5	5,082.00	5,082.50	202.78	0.006	1.22	0.10	5,077.34	5,076.12	6.38	2.50	3	3		1293.063
RED 6	5,086.50	5,082.50	265.45	0.006	1.59	0.10	5,079.34	5,077.75	4.75	2.50	9	9		1261.604
RED 7	5,082.50	5,081.75	444.09	0.006	2.66	0.10	5,077.65	5,074.98	6.77	2.50	4	16	1	3005.264
RED 8	5,084.00	5,081.75	260.88	0.006	1.57	0.10	5,078.64	5,077.07	4.68	2.50	9	9		1219.687
RED 9	5,081.75	5,077.50	421.26	0.006	2.53	0.10	5,074.88	5,072.35	5.15	2.50	4	4	1	2168.461
RED 10	5,082.00	5,077.50	263.90	0.006	1.58	0.10	5,072.94	5,071.36	6.14	2.50	9	9		1621.243
RED 11	5,077.50	5,069.70	387.81	0.006	2.33	0.10	5,067.37	5,065.04	4.66	2.50	4	42		1805.977
RED 12	5,079.80	5,069.70	477.09	0.006	2.86	0.10	5,067.90	5,065.04	4.66	2.50	9	9	1	2224.451
RED 13	5,069.70	5,068.75	381.06	0.006	2.29	0.10	5,064.94	5,062.65	6.10	2.50	2	53		2324.047
RED 14	5,058.10	5,056.90	259.06	0.006	1.55	0.10	5,053.44	5,051.89	5.01	2.50	7	7		1299.02
RED 15	5,056.90	5,058.75	1,182.09	0.006	7.09	0.10	5,051.79	5,044.69	14.06	2.50	25	32	3	16616.52
RED 16	5,058.75	5,064.90	421.47	0.006	2.53	0.10	5,044.59	5,042.06	22.84	2.50	5	37	1	9624.571

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES	
RED 17	5,061.30	5,060.00	201.49	0.006	1.21	0.10	5,056.55	5,055.34	4.66	2.50	4	4		938.7298
RED 18	5,063.75	5,060.00	212.71	0.006	1.28	0.10	5,055.24	5,053.96	6.04	2.50	6	6		1283.747
RED 19	5,060.00	5,060.00	602.76	0.006	3.62	0.10	5,053.86	5,050.25	9.75	2.50	8	18	1	5877.971
RED 20	5,070.00	5,062.50	630.42	0.006	3.78	0.10	5,061.62	5,057.84	4.66	2.50	13	13	1	2939.346
RED 21	5,062.50	5,060.00	120.94	0.006	0.73	0.10	5,056.07	5,055.34	4.66	2.50	2	15		563.0531
RED 22	5,060.00	5,064.90	353.39	0.006	2.12	0.10	5,062.24	5,060.12	4.78	2.50	4	37		1689.324
RED 23	5,066.90	5,064.90	197.25	0.006	1.18	0.10	5,061.42	5,060.24	4.66	2.50	7	7		919.8754
RED 24	5,064.90	5,068.75	367.87	0.006	2.21	0.10	5,041.96	5,039.75	29.00	2.50	0	81		10667.21
RED 25	5,068.75	5,062.50	394.40	0.006	2.37	0.10	5,039.65	5,037.29	25.21	2.50	7	183		9944.252
RED 26	5,062.50	5,056.80	423.50	0.006	2.54	0.10	5,037.19	5,034.65	22.15	2.50	8	191	1	9380.949
RED 27	5,070.50	5,062.00	256.81	0.006	1.54	0.10	5,058.88	5,057.34	4.66	2.50	7	7		1196.955
RED 28	5,062.00	5,058.75	239.00	0.006	1.43	0.10	5,055.52	5,054.09	4.66	2.50	3	10		1114.696
RED 29	5,059.70	5,058.75	271.81	0.006	1.63	0.10	5,055.04	5,053.41	5.34	2.50	7	7		1451.699
RED 30	5,058.75	5,055.00	340.22	0.006	2.04	0.10	5,052.38	5,050.34	4.66	2.50	3	20		1585.874
RED 31	5,075.60	5,070.10	514.14	0.006	3.08	0.10	5,068.52	5,065.44	4.66	2.50	9	9	1	2398.381
RED 32	5,070.10	5,062.60	224.04	0.006	1.34	0.10	5,059.28	5,057.94	4.66	2.50	2	11		1044.976
RED 33	5,065.00	5,062.60	108.41	0.006	0.65	0.10	5,058.34	5,057.69	4.91	2.50	4	4		532.343
RED 34	5,062.60	5,058.75	303.87	0.006	1.82	0.10	5,055.91	5,054.09	4.66	2.50	2	17		1417.013
RED 35	5,059.75	5,059.70	258.40	0.006	1.55	0.10	5,056.59	5,055.04	4.66	2.50	4	4		1204.247
RED 36	5,059.70	5,058.75	245.59	0.006	1.47	0.10	5,054.94	5,053.47	5.28	2.50	6	10		1297.683
RED 37	5,058.75	5,055.00	674.42	0.006	4.05	0.10	5,053.37	5,049.32	5.68	2.50	10	37	1	3831.016
RED 38	5,051.90	5,055.00	252.11	0.006	1.51	0.10	5,047.24	5,045.73	9.27	2.50	2	2		2337.73
RED 39	5,055.00	5,056.80	360.43	0.006	2.16	0.10	5,045.63	5,043.47	13.33	2.50	2	61		4805.462
RED 40	5,056.80	5,049.40	623.25	0.006	3.74	0.10	5,034.55	5,030.81	18.59	2.50	8	260	1	11585.91
RED 41	5,068.00	5,058.10	975.26	0.006	5.85	0.10	5,059.29	5,053.44	4.66	2.50	7	7	2	4546.233
RED 42	5,058.10	5,052.50	715.45	0.006	4.29	0.10	5,052.13	5,047.84	4.66	2.50	6	13	1	3335.929
RED 43	5,061.20	5,057.80	344.34	0.006	2.07	0.10	5,053.14	5,051.07	6.73	2.50	5	5		2316.045
RED 44	5,057.80	5,054.40	399.04	0.006	2.39	0.10	5,050.97	5,048.58	5.82	2.50	4	9		2322.525
RED 45	5,051.00	5,054.40	653.48	0.006	3.92	0.10	5,048.48	5,044.56	9.84	2.50	15	15	1	6431.001
RED 46	5,054.40	5,052.50	203.71	0.006	1.22	0.10	5,044.46	5,043.24	9.26	2.50	0	24		1887.051
RED 47	5,052.50	5,049.40	1,019.26	0.006	6.12	0.10	5,043.14	5,037.02	12.38	2.50	1	38	2	12617.4
														0
									385.46					0
														0
			57,269.94											0
														0
														0
														0
														0
														0
														0
												8.70		498197.7
			-											

COLD SPRINGS SEWER DESIGN

2-LIFT STATION

Min Cover =	4.67	Top of Pipe to FG
Pipe Dia. =	0.67	8" dia.
Std. Slope =	0.006	
n =	0.014	

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES		pipe length/pie depth
RED 1	5,069.00	5,069.00	521.82	0.006	3.13	-	5,064.33	5,061.20	8.46	2.50	12	12	1		4416.817
RED 2	5,069.00	5,068.00	474.31	0.006	2.85	0.10	5,061.10	5,058.26	9.74	2.50	7	19			4621.414
RED 3	5,069.00	5,068.00	251.44	0.006	1.51	0.10	5,064.34	5,062.83	5.17	2.50	4	4			1299.603
RED 4	5,068.00	5,066.00	486.29	0.006	2.92	0.10	5,062.73	5,059.81	6.19	2.50	9	32			3008.375
RED 5	5,066.00	5,057.00	1,233.40	0.006	7.40	0.10	5,059.71	5,052.31	4.69	2.50	25	57			5780.674
RED 6	5,057.00	5,055.00	232.17	0.006	1.39	0.10	5,052.21	5,050.82	4.18	2.50	3	60			970.4242
RED 7	5,055.00	5,052.00	184.71	0.006	1.11	0.10	5,050.72	5,049.61	2.39	2.50	2	224			441.0986
RED 8	5,052.00	5,050.00	213.25	0.006	1.28	0.10	5,049.51	5,048.23	1.77	2.50	3	227			376.9322
RED 9	5,050.00	5,050.00	208.95	0.006	1.25	0.10	5,048.13	5,046.88	3.12	2.50	1	347			652.1873
RED 10	5,050.00	5,049.00	58.15	0.006	0.35	0.10	5,046.78	5,046.43	2.57	2.50	0	347			149.4548
RED 11	5,068.00	5,068.00	608.33	0.006	3.65	0.10	5,063.34	5,059.69	8.31	2.50	12	12			5055.21
RED 12	5,067.00	5,066.00	261.67	0.006	1.57	0.10	5,062.34	5,060.77	5.23	2.50	9	9			1368.539
RED 13	5,066.00	5,063.00	702.85	0.006	4.22	0.10	5,060.67	5,056.45	6.55	2.50	14	23			4601.643
RED 14	5,063.00	5,060.00	163.81	0.006	0.98	0.10	5,056.35	5,055.37	4.63	2.50	2	25			758.437
RED 15	5,061.00	5,060.00	145.90	0.006	0.88	0.10	5,055.27	5,054.39	5.61	2.50	3	3			817.8249
RED 16	5,060.00	5,060.00	345.28	0.006	2.07	0.10	5,054.29	5,052.22	7.78	2.50	3	28			2685.263
RED 17	5,067.00	5,067.00	494.91	0.006	2.97	0.10	5,062.34	5,059.37	7.63	2.50	9	9			3775.896
RED 18	5,066.00	5,065.00	187.23	0.006	1.12	0.10	5,061.34	5,060.22	4.78	2.50	5	5			895.5922
RED 19	5,066.00	5,065.00	178.24	0.006	1.07	0.10	5,060.12	5,059.05	5.95	2.50	4	4			1061.031
RED 20	5,065.00	5,064.00	308.97	0.006	1.85	0.10	5,058.95	5,057.09	6.91	2.50	4	13			2133.945
RED 21	5,064.00	5,063.00	296.21	0.006	1.78	0.10	5,056.99	5,055.22	7.78	2.50	3	16			2305.669
RED 22	5069	5068	283	0.006	1.70	0.10	5,064.34	5,062.64	5.36	2.50	5	5			1516.314
RED 23	5068	5067	274.57	0.006	1.65	0.10	5,062.54	5,060.89	6.11	2.50	4	16			1676.365
RED 24	5067	5065	237.04	0.006	1.42	0.10	5,060.79	5,059.37	5.63	2.50	6	22			1333.981
RED 25	5065	5063	681.37	0.006	4.09	0.10	5,059.27	5,055.18	7.82	2.50	12	34			5325.506
RED 26	5063	5060	315.32	0.006	1.89	0.10	5,055.08	5,053.19	6.81	2.50	4	97			2146.635
RED 27	5060	5055	371.76	0.006	2.23	0.10	5,053.09	5,050.86	4.14	2.50	4	141			1538.477
RED 28	5055	5055	204.29	0.006	1.23	0.10	5,050.76	5,049.54	5.46	2.50	3	158			1116.261
RED 29	5055	5055	256.45	0.006	1.54	0.10	5,049.44	5,047.90	7.10	2.50	4	162			1821.513
RED 30	5060	5060	309.83	0.006	1.86	0.10	5,047.80	5,045.94	14.06	2.50	2	9			4356.761
RED 31	5060	5061	260.58	0.006	1.56	0.10	5,055.34	5,053.78	7.22	2.50	7	7			1882.294
RED 32	5060	5058	171.39	0.006	1.03	0.10	5,055.34	5,054.31	3.69	2.50	4	4			632.1446
RED 33	5058	5056	142.62	0.006	0.86	0.10	5,054.21	5,053.36	2.64	2.50	2	6			377.0958
RED 34	5056	5055	635.14	0.006	3.81	0.10	5,053.26	5,049.45	5.55	2.50	8	14			3528.139
RED 35	5043	5042	316.01	0.006	1.90	0.10	5,038.34	5,036.44	5.56	2.50	2	2			1755.771
RED 36	5042	5045	439.91	0.006	2.64	0.10	5,036.34	5,033.70	11.30	2.50	3	5			4969.012
RED 37	5045	5046	73.26	0.006	0.44	0.10	5,033.60	5,033.16	12.84	2.50	1	6			940.298
RED 38	5046	5047	118.59	0.006	0.71	0.10	5,042.34	5,041.63	5.37	2.50	5	5			637.0109
RED 39	5045	5048	371.57	0.006	2.23	0.10	5,041.53	5,039.30	8.70	2.50	4	16			3233.016
RED 40	5048	5049	354.29	0.006	2.13	0.10	5,044.34	5,042.21	6.79	2.50	7	7			2404.12
RED 41	5048	5053	364.05	0.006	2.18	0.10	5,042.11	5,039.93	13.07	2.50	4	27			4758.148

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES		pipe length/pie depth
RED 42	5053	5052	849.38	0.006	5.10	0.10	5,039.83	5,034.73	17.27	2.50	14	79			14665.67
RED 43	5052	5050	622.99	0.006	3.74	0.10	5,034.63	5,030.90	19.10	2.50	9	88			11901.76
RED 44	5048	5050	326.14	0.006	1.96	0.10	5,030.80	5,028.84	21.16	2.50	4	31			6901.481
RED 45	5048	5047	301.8	0.006	1.81	0.10	5,028.74	5,026.93	20.07	2.50	4	27			6057.699
RED 46	5047	5046	256.58	0.006	1.54	0.10	5,026.83	5,025.29	20.71	2.50	4	23			5314.126
RED 47	5047	5046	139.61	0.006	0.84	0.10	5,042.34	5,041.50	4.50	2.50	3	3			627.9183
RED 48	5046	5042	300.86	0.006	1.81	0.10	5,041.40	5,039.60	2.40	2.50	3	16			722.9124
RED 49	5043	5042	245.2	0.006	1.47	0.10	5,038.34	5,036.87	5.13	2.50	6	6			1258.17
RED 50	5043	5042	253.38	0.006	1.52	0.10	5,036.77	5,035.25	6.75	2.50	4	7			1710.69
RED 51	5043	5043	115.84	0.006	0.70	0.10	5,038.34	5,037.64	5.36	2.50	3	3			620.3278
RED 52	5070	5067	683.23	0.006	4.10	0.10	5,065.34	5,061.24	5.76	2.50	13	13			3934.981
RED 53	5068	5067	339.36	0.006	2.04	0.10	5,063.34	5,061.30	5.70	2.50	3	3			1933.049
RED 54	5067	5065	918.24	0.006	5.51	0.10	5,038.34	5,032.83	32.17	2.50	15	31			29539.27
RED 55	5066	5065	428.71	0.006	2.57	0.10	5,061.34	5,058.77	6.23	2.50	5	5			2671.832
RED 56	5065	5064	421.82	0.006	2.53	0.10	5,038.34	5,035.81	28.19	2.50	6	42			11891.49
RED 57	5064	5063	201.67	0.006	1.21	0.10	5,038.34	5,037.13	25.87	2.50	1	43			5217.207
RED 58	5065	5061	426.76	0.006	2.56	0.10	5,060.34	5,057.78	3.22	2.50	4	4			1374.406
RED 59	5061	5060	278.72	0.006	1.67	0.10	5,056.34	5,054.67	5.33	2.50	6	6			1486.224
RED 60	5060	5060	317.58	0.006	1.91	0.10	5,055.34	5,053.43	6.57	2.50	5	11			2085.065
RED 61	5061	5060	179.14	0.006	1.07	0.10	5,056.34	5,055.27	4.73	2.50	3	3			848.1992
RED 62	5060	5061	197.64	0.006	1.19	0.10	5,038.34	5,037.15	23.85	2.50	1	14			4712.892
RED 63	5061	5056	357.64	0.006	2.15	0.10	5,038.34	5,036.19	19.81	2.50	1	19			7083.361
RED 64	5060	5056	512.31	0.006	3.07	0.10	5,055.34	5,052.27	3.73	2.50	8	8			1912.894
RED 65	5056	5053	356.56	0.006	2.14	0.10	5,038.34	5,036.20	16.80	2.50	3	30			5989.98
RED 66	5054	5053	542.17	0.006	3.25	0.10	5,049.34	5,046.09	6.91	2.50	8	8			3748.032
GREEN 1	5070	5070	376.48	0.006	2.26	0.10	5,065.34	5,063.08	6.92	2.50	3	3			2604.82
GREEN 2	5071	5070	162.9	0.006	0.98	0.10	5,066.34	5,065.36	4.64	2.50	3	3			755.4325
GREEN 3	5070	5070	485.89	0.006	2.92	0.10	5,049.34	5,046.42	23.58	2.50	3	9			11455.02
GREEN 4	5071	5070	372.1	0.006	2.23	0.10	5,049.34	5,047.11	22.89	2.50	4	9			8518.336
GREEN 5	5071	5071	172.2	0.006	1.03	0.10	5,066.34	5,065.31	5.69	2.50	4	4			980.369
GREEN 6	5070	5070	357.11	0.006	2.14	0.10	5,049.34	5,047.20	22.80	2.50	3	21			8143.058
GREEN 7	5070	5071	385.5	0.006	2.31	0.10	5,049.34	5,047.03	23.97	2.50	7	57			9241.591
GREEN 8	5071	5075	321.18	0.006	1.93	0.10	5,049.34	5,047.41	27.59	2.50	5	62			8860.418
GREEN 9	5075	5075	140.66	0.006	0.84	0.10	5,070.34	5,069.50	5.50	2.50	4	4			774.187
GREEN 10	5075	5076	185.79	0.006	1.11	0.10	5,049.34	5,048.23	27.77	2.50	2	68			5160.269
GREEN 11	5076	5079	233.5	0.006	1.40	0.10	5,049.34	5,047.94	31.06	2.50	3	71			7252.743
GREEN 12	5078	5079	188.17	0.006	1.13	0.10	5,049.34	5,048.21	30.79	2.50	1	6			5793.57
GREEN 13	5078	5078	90.09	0.006	0.54	0.10	5,073.34	5,072.80	5.20	2.50	3	3			468.5166
GREEN 14	5081	5078	646.18	0.006	3.88	0.10	5,076.34	5,072.46	5.54	2.50	12	12			3577.95
GREEN 15	5079	5075	674.31	0.006	4.05	0.10	5,049.34	5,045.29	29.71	2.50	12	99			20030.96
GREEN 16	5075	5072	491.6	0.006	2.95	0.10	5,049.34	5,046.39	25.61	2.50	9	156			12589.68
GREEN 17	5072	5067	213.54	0.006	1.28	0.10	5,049.34	5,048.06	18.94	2.50	4	160			4044.712
GREEN 18	5067	5062	394.4	0.006	2.37	0.10	5,049.34	5,046.97	15.03	2.50	7	297			5926.412
GREEN 19	5062	5056	423.25	0.006	2.54	0.10	5,049.34	5,046.80	9.20	2.50	9	306			3893.688
GREEN 20	5056	5054	623.25	0.006	3.74	0.10	5,049.34	5,045.60	8.40	2.50	10	377			5234.988
GREEN 21	5081	5081	202.78	0.006	1.22	0.10	5,049.34	5,048.12	32.88	2.50	3	3			6666.733
GREEN 22	5083	5081	265.45	0.006	1.59	0.10	5,078.34	5,076.75	4.25	2.50	9	9			1128.879
GREEN 23	5081	5081	444.09	0.006	2.66	0.10	5,049.34	5,046.68	34.32	2.50	5	16			15243.18
GREEN 24	5083	5081	260.88	0.006	1.57	0.10	5,078.34	5,076.77	4.23	2.50	8	8			1102.291

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES		pipe length/pie depth
GREEN 25	5081	5077	421.26	0.006	2.53	0.10	5,049.34	5,046.81	30.19	2.50	5	29			12716.81
GREEN 26	5081	5077	263.9	0.006	1.58	0.10	5,076.34	5,074.76	2.24	2.50	7	7			592.0333
GREEN 27	5077	5070	387.81	0.006	2.33	0.10	5,049.34	5,047.01	22.99	2.50	7	43			8914.534
GREEN 28	5079	5070	477.09	0.006	2.86	0.10	5,074.34	5,071.48	(1.48)	2.50	8	8			-704.881
GREEN 29	5070	5067	381.06	0.006	2.29	0.10	5,049.34	5,047.05	19.95	2.50	2	51			7600.76
GREEN 30	5070	5062	256.81	0.006	1.54	0.10	5,065.34	5,063.80	(1.80)	2.50	7	7			-462.037
GREEN 31	5062	5058	239	0.006	1.43	0.10	5,049.34	5,047.91	10.09	2.50	4	11			2412.466
GREEN 32	5059	5058	271.81	0.006	1.63	0.10	5,054.34	5,052.71	5.29	2.50	6	6			1438.109
GREEN 33	5058	5056	340.22	0.006	2.04	0.10	5,049.34	5,047.30	8.70	2.50	4	21			2960.363
GREEN 34	5075	5070	514.14	0.006	3.08	0.10	5,070.34	5,067.26	2.74	2.50	9	9			1411.232
GREEN 35	5070	5065	224.04	0.006	1.34	0.10	5,049.34	5,048.00	17.00	2.50	5	14			3809.63
GREEN 36	5065	5065	108.41	0.006	0.65	0.10	5,060.34	5,059.69	5.31	2.50	3	3			575.707
GREEN 37	5065	5057	303.87	0.006	1.82	0.10	5,049.34	5,047.52	9.48	2.50	3	20			2881.666
GREEN 38	5059	5059	258.4	0.006	1.55	0.10	5,054.34	5,052.79	6.21	2.50	5	5			1604.767
GREEN 39	5059	5059	245.59	0.006	1.47	0.10	5,049.34	5,047.87	11.13	2.50	3	8			2734.286
GREEN 40	5059	5056	674.42	0.006	4.05	0.10	5,049.34	5,045.29	10.71	2.50	9	37			7220.691
GREEN 40A	5056	5056	360.43	0.006	2.16	0.10	5,049.34	5,047.18	8.82	2.50	1	53			3179.923
GREEN 41	5055	5056	252.11	0.006	1.51	0.10	5,050.34	5,048.83	7.17	2.50	2	2			1808.299
GREEN 42	5055	5058	653.48	0.006	3.92	0.10	5,050.34	5,046.42	11.58	2.50	14	14			7567.873
GREEN 43	5059	5058	399.04	0.006	2.39	0.10	5,049.34	5,046.95	11.05	2.50	7	16			4411.084
GREEN 44	5061	5059	344.34	0.006	2.07	0.10	5,056.34	5,054.27	4.73	2.50	9	9			1627.365
GREEN 45	5061	5058	975.26	0.006	5.85	0.10	5,056.34	5,050.49	7.51	2.50	0	0			7325.724
GREEN 46	5058	5056	715.45	0.006	4.29	0.10	5,049.34	5,045.05	10.95	2.50	0	0			7836.109
GREEN 47	5058	5056	203.71	0.006	1.22	0.10	5,049.34	5,048.12	7.88	2.50	0	30			1605.695
GREEN 48	5056	5054	1019.26	0.006	6.12	0.10	5,049.34	5,043.22	10.78	2.50	0	30			10983.1
GREEN 49	5072	5068	724.96	0.006	4.35	0.10	5,049.34	5,044.99	23.01	2.50	8	8			16681.16
GREEN 50	5068	5070	139.05	0.006	0.83	0.10	5,049.34	5,048.51	21.49	2.50	1	17			2988.782
GREEN 51	5070	5070	180.31	0.006	1.08	0.10	5,065.34	5,064.26	5.74	2.50	5	5			1035.315
GREEN 52	5070	5070	538.66	0.006	3.23	0.10	5,049.34	5,046.11	23.89	2.50	7	29			12869.64
GREEN 54	5070	5071	341.38	0.006	2.05	0.10	5,049.34	5,047.29	23.71	2.50	2	2			8093.533
GREEN 55	5071	5072	265.96	0.006	1.60	0.10	5,049.34	5,047.74	24.26	2.50	4	31			6451.062
GREEN 56	5072	5073	508.52	0.006	3.05	0.10	5,049.34	5,046.29	26.71	2.50	8	39			13583.14
GREEN 57	5073	5072	317.88	0.006	1.91	0.10	5,049.34	5,047.43	24.57	2.50	6	45			7809.447
GREEN 58	5072	5075	361.07	0.006	2.17	0.10	5,049.34	5,047.17	27.83	2.50	3	48			10047.29
GREEN 59	5061	5060	201.49	0.006	1.21	0.10	5,056.34	5,055.13	4.87	2.50	5	5			981.0427
GREEN 60	5065	5060	212.71	0.006	1.28	0.10	5,060.34	5,059.06	0.94	2.50	5	5			199.1519
GREEN 61	5060	5060	602.76	0.006	3.62	0.10	5,049.34	5,045.72	14.28	2.50	9	19			8605.339
GREEN 62	5070	5062	630.42	0.006	3.78	0.10	5,065.34	5,061.56	0.44	2.50	13	13			278.9735
GREEN 63	5062	5060	120.94	0.006	0.73	0.10	5,049.34	5,048.61	11.39	2.50	1	14			1376.979
GREEN 64	5060	5065	353.39	0.006	2.12	0.10	5,049.34	5,047.22	17.78	2.50	5	38			6283.394
GREEN 65	5067	5065	197.25	0.006	1.18	0.10	5,062.34	5,061.16	3.84	2.50	6	6			758.1304
GREEN 66	5065	5067	367.87	0.006	2.21	0.10	5,049.34	5,047.13	19.87	2.50	1	79			7308.554
GREEN 67	5059	5065	421.47	0.006	2.53	0.10	5,049.34	5,046.81	18.19	2.50	5	34			7666.042
GREEN 68	5058	5059	1182.09	0.006	7.09	0.10	5,049.34	5,042.25	16.75	2.50	24	29			19803.01
GREEN 69	5059	5058	259.06	0.006	1.55	0.10	5,054.34	5,052.79	5.21	2.50	5	5			1350.832
GREEN 70	5059	5064	145.75	0.006	0.87	0.10	5,054.34	5,053.47	10.53	2.50	5	5			1535.403
GREEN 71	5062	5064	133.35	0.006	0.80	0.10	5,057.34	5,056.54	7.46	2.50	2	2			994.8043
GREEN 72	5064	5068	119.17	0.006	0.72	0.10	5,049.34	5,048.62	19.38	2.50	1	8			2308.921
GREEN 73	5059	5059	358.19	0.006	2.15	0.10	5,054.34	5,052.19	6.81	2.50	2	2			2438.966

PIPE NO.	GROUND ELEVATION BEGIN	GROUND ELEVATION END	PIPE LENGTH	SLOPE	FALL IN PIPE	DELTA INV.	INVERT BEGIN	INVERT END	COVER AT END	VELOCITY AT d=0.5D	# OF HOMES	TOTAL HOMES	# OF INTERMENIATE MANHOLES		pipe length/pie depth
GREEN 74	5059	5061	859.27	0.006	5.16	0.10	5,049.34	5,044.18	16.82	2.50	14	16			14449.16
GREEN 75	5061	5065	241.24	0.006	1.45	0.10	5,049.34	5,047.89	17.11	2.50	3	19			4126.999
GREEN 76	5065	5070	168.98	0.006	1.01	0.10	5,049.34	5,048.33	21.67	2.50	3	22			3662.452
GREEN 77	5070	5071	265.95	0.006	1.60	0.10	5,049.34	5,047.74	23.26	2.50	3	25			6184.853
GREEN 78	5059	5057	318.97	0.006	1.91	0.10	5,054.34	5,052.43	4.57	2.50	2	2			1458.911
GREEN 79	5057	5057	463.7	0.006	2.78	0.10	5,049.34	5,046.56	10.44	2.50	7	9			4842.048
GREEN 80	5057	5056	112.94	0.006	0.68	0.10	5,049.34	5,048.66	7.34	2.50	3	12			828.7131
GREEN 81	5056	5055	465.51	0.006	2.79	0.10	5,049.34	5,046.55	8.45	2.50	8	20			3934.984
GREEN 82	5055	5054	234.52	0.006	1.41	0.10	5,049.34	5,047.93	6.07	2.50	4	42			1422.861
GREEN 83	5054	5053	175.86	0.006	1.06	0.10	5,049.34	5,048.28	4.72	2.50	3	45			829.208
GREEN 84	5057	5055	463.48	0.006	2.78	0.10	5,052.34	5,049.56	5.44	2.50	7	7			2521.739
GREEN 85	5055	5055	224.42	0.006	1.35	0.10	5,049.34	5,047.99	7.01	2.50	2	9			1572.403
GREEN 86	5056	5055	224.42	0.006	1.35	0.10	5,051.34	5,049.99	5.01	2.50	4	4			1123.563
GREEN 87	5055	5055	162.51	0.006	0.98	0.10	5,049.34	5,048.36	6.64	2.50	2	15			1078.264
GREEN 88	5055	5055	329.6	0.006	1.98	0.10	5,049.34	5,047.36	7.64	2.50	3	18			2517.353
GREEN 89	5053	5053	452.32	0.006	2.71	0.10	5,049.34	5,046.63	6.37	2.50	1	43			2883.051
GREEN 90	5054	5053	192.59	0.006	1.16	0.10	5,049.34	5,048.18	4.82	2.50	1	9			927.4248
GREEN 91	5054	5054	221.84	0.006	1.33	0.10	5,049.34	5,048.01	5.99	2.50	8	8			1329.052
GREEN 92	5053	5054	519.32	0.006	3.12	0.10	5,049.34	5,046.22	7.78	2.50	1	52			4038.191
GREEN 93	5054	5054	204.69	0.006	1.23	0.10	5,049.34	5,048.11	5.89	2.50	1	8			1205.243
GREEN 94	5055	5054	178.6	0.006	1.07	0.10	5,050.34	5,049.27	4.73	2.50	7	7			845.0638
GREEN 95	5054	5054	612.57	0.006	3.68	0.10	5,049.34	5,045.66	8.34	2.50	1	61			5106.028
			57,491.47												687170.1