# REVISED INTERIM ACTION WORK PLAN

# FOR

# WASTEWATER TREATMENT AND DISPOSAL

# AT

# BIG SKY, MONTANA

October 1995

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MSE-HKM ENGINEERING

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# REVISED INTERIM ACTION WORK PLAN

## I. INTRODUCTION

On July 13, 1993 the Water Quality Bureau issued a Compliance Order to Rural Improvement District 305 (RID 305) to make improvements to the District's wastewater treatment facility. The Compliance Order required the District to submit an Interim Action Work Plan (IAWP) outlining the steps the District will take to enhance water conservation, improve treatment, and reduce inflow and infiltration.

Subsequent to the issuance of the Compliance Order, the voters approved the creation of the Big Sky County Water and Sewer District 363 (District). After a review of assets and liabilities, the District assumed the responsibilities of RID 305 on February 16, 1994.

On December 13, 1994, HKM submitted an Interim Action Work Plan on behalf of the District. On January 31, 1995, the Water Quality Bureau approved the Interim Action Work Plan. The IAWP consisted of the following 3 components:

- Improved Treatment
- Reduction of infiltration and inflow
- Water Conservation Measures

During the summer of 1995, the District completed the improvements approved under the IAWP. The improvements included adding a hypalon curtain wall in the existing aeration cell and adding six 5 HP aerators in the first cell and two 5 HP aerators in the second cell.

On August 31, 1995 the Montana Department of Environmental Quality issued the first Amendment to the Compliance Order. The Amendment to the Compliance Order required the District to submit a revised IAWP by November 1, 1995. The revised IAWP must describe additional proposed interim measures and time frames for the following items:

a. Improvements to the existing treatment facility, including the addition of filtration, new storage, and lining of the existing ponds;
b. Expansion of the land application process; and
c. Development of an improved land application management and monitoring plan.

The following sections of this report describe the improvements and schedules proposed by the District to meet the requirements of the Amended Compliance Order.

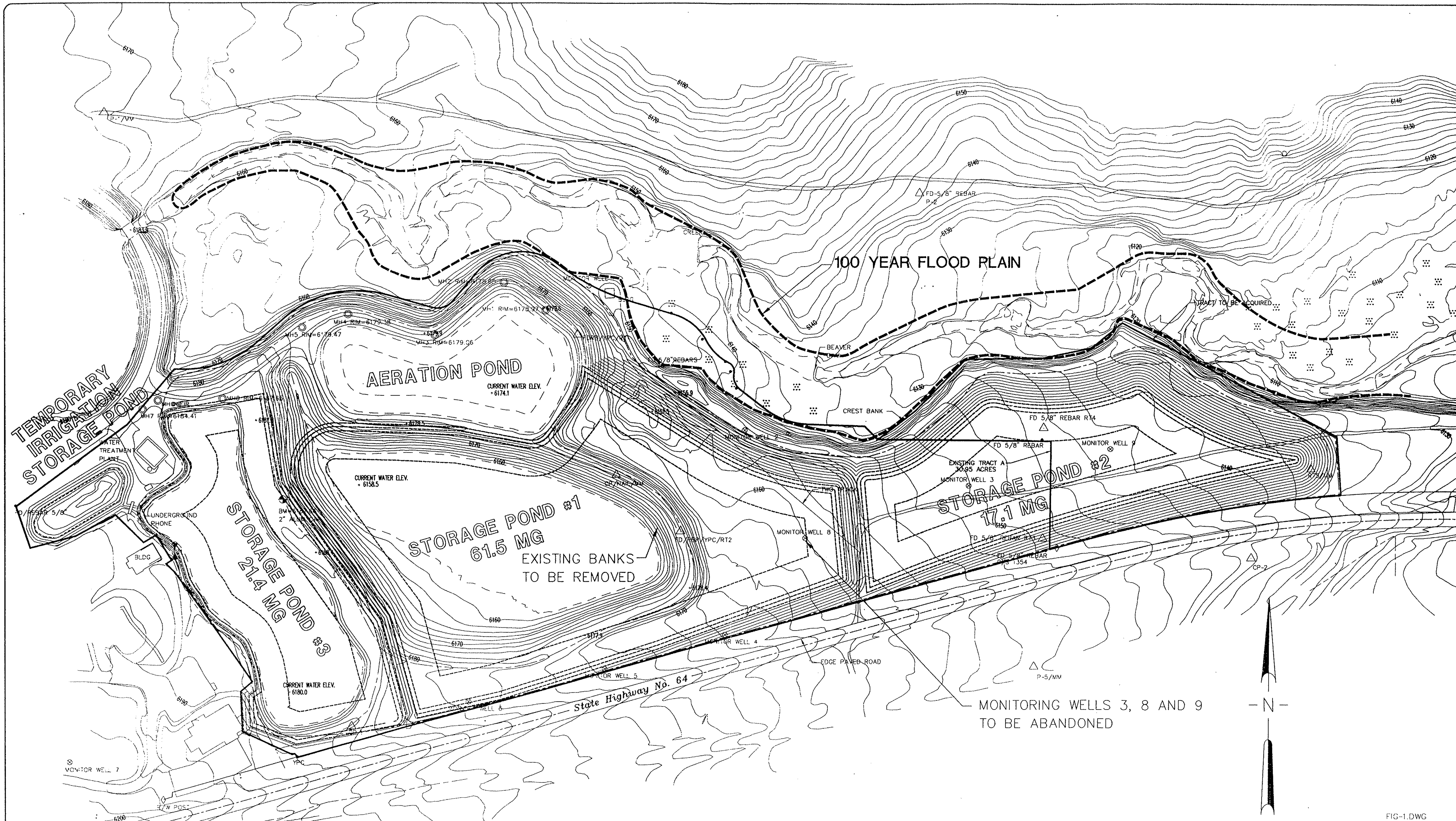
## II. STORAGE IMPROVEMENTS

Figure 1 shows the site plan for the storage improvements. The storage improvements will consist of constructing a new 17.1 MG storage pond (pond 2), enlarging storage pond 1 to 61.5 MG, and enlarging Pond 3 to 21.4 MG. The new and enlarged storage ponds will provide a total storage volume of 100.02 MG. The ponds will be constructed with 3:1 interior and exterior side slopes. The ponds will be lined with a 40 mil High Density Polyethylene (HDPE) liner. Aeration will be provided in each pond to help control algae growth and to maintain aerobic conditions. Storage improvements completed in the IAWP will be part of the long range plan.

Overflow piping will be installed between the ponds to allow water to flow between the ponds. During the interim phase, pond 3 will contain treated, chlorinated and filtered water while Pond 1 and Pond 2 will contain treated (but unfiltered, unchlorinated) water from the aeration pond. After the advanced treatment plant is constructed, all the ponds could contain treated, filtered, chlorinated water. Piping flexibility will be provided to allow storage Pond 2 to fill directly from the advanced wastewater treatment plant when it is constructed. This mode of operation will provide an equalization pond between the wastewater treatment plant and the filters and will allow the filters to operate at a constant flow rate. In this mode of operation Pond 2 would contain treated water but the water would not be filtered or chlorinated.

The recirculation pump station will be provided with piping flexibility to allow water to be pumped from either Pond 1 or Pond 2, to the filter system or to Pond 3. Figure 2 shows the process flow diagram for the storage pond piping. The piping flexibility would allow Pond 3 to be refilled without having to refilter the stored water.

The enlargement of pond 1 and the construction of pond 2 will require that 3 of the existing monitoring wells be abandoned. The wells will be abandoned according to the standards for monitor well abandonment contained at ARM 36.21.810. Three new monitoring wells will be installed to allow continued monitoring of the groundwater around the storage ponds.




## SITE PLAN

SCALE: 1"=200'

OVERALL STORAGE PLAN

WASTEWATER TREATMENT PLANT MODIFICATIONS

BIG SKY, MONTANA

FIGURE 1

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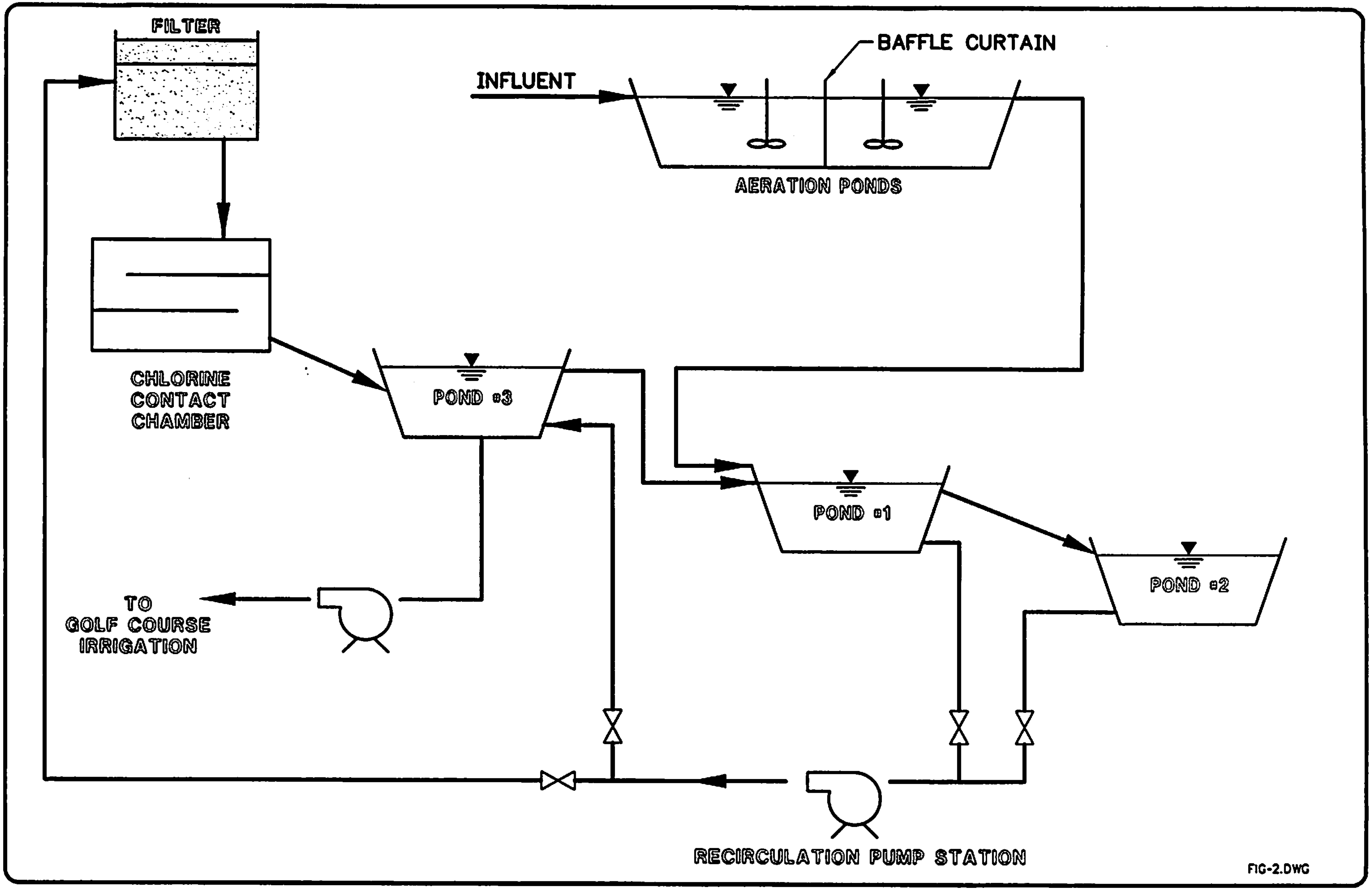


STORAGE POND PROCESS FLOW DIAGRAM

WASTEWATER TREATMENT PLANT MODIFICATIONS
BIG SKY, MONTANA

FIGURE 2

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## III. TREATMENT IMPROVEMENTS

In order to improve the quality of water used to irrigate the golf course a coagulation/flocculation/sedimentation and filtration system will be installed. The treatment system will be located in the existing treatment plant building. The building will be expanded to house the new treatment equipment. Figure 3 shows the general arrangement of the proposed treatment system. Figure 4 shows the process and instrumentation diagram.

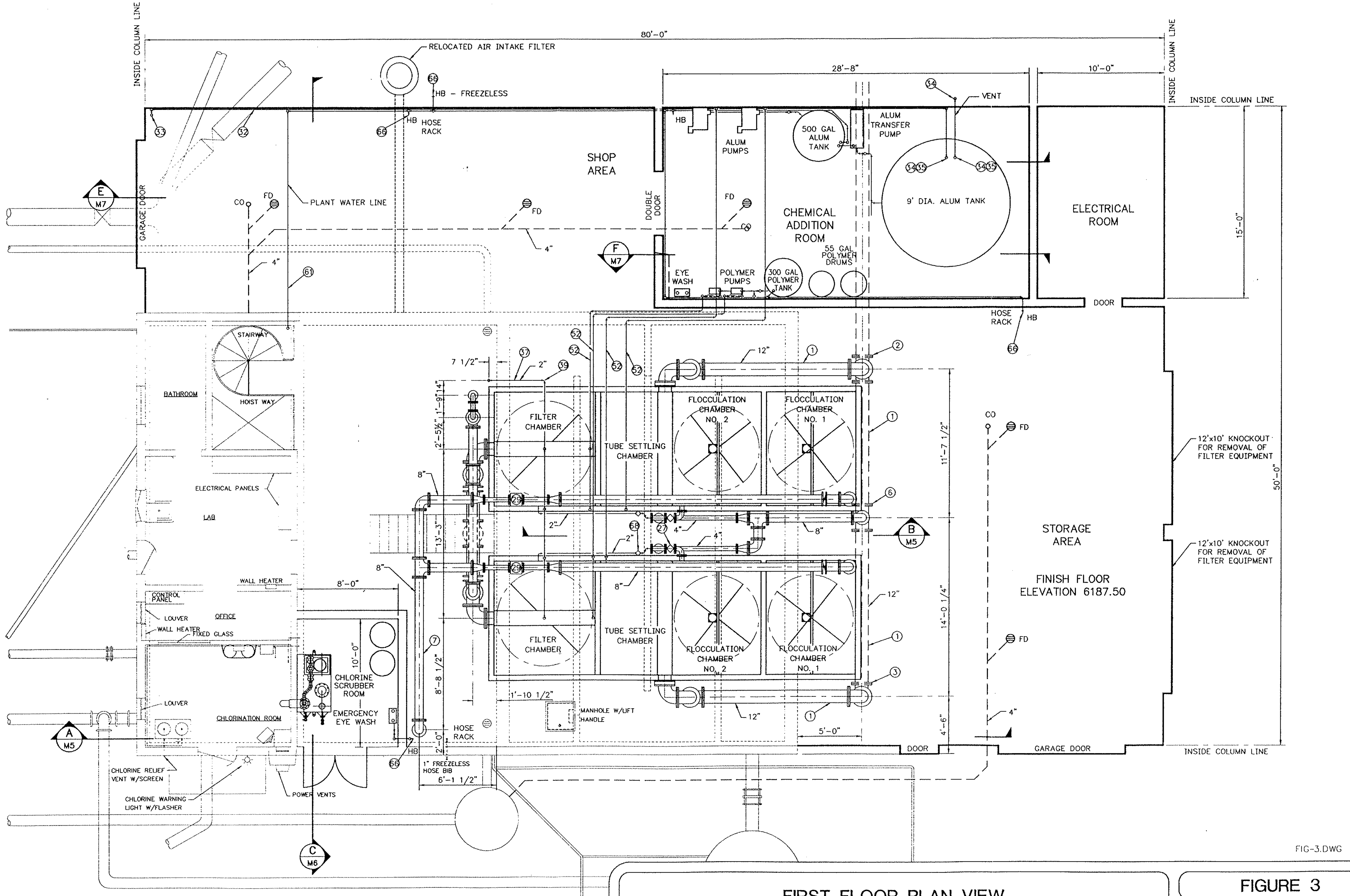
The treatment system is designed to treat a flow of 0.5 MGD based on a 22 hour treatment day. A 22 hour day is utilized to allow time for backwashing. Each filter train will operate at a filtration rate of 2.5 gpm/$ft^2$ during normal operation. With one filter out of service the filtration rate will be 5 gpm/$ft^2$ which is the maximum filtration rate based on state design criteria. Water will be pumped to the filters using constant speed pumps at the existing recirculation pump station. During the backwash cycle the recirculation pumps will be shut off automatically.

A flocculation chamber and tube settler or plate settler will be used for pre-treatment before the filters.

The chemical feed system will consist of liquid alum for coagulation/flocculation and a polymer addition for a filter aid. A 7,500 gallon liquid alum tank will be located in a separate chemical feed room. During the interim phase, when lagoon effluent is being filtered, it is anticipated that alum doses of 25 mg/l to 75 mg/l will be used. The chlorine feed system will be modified to allow chlorine to be fed in front of the filters to control biological growth on the filters.

An air scour backwash system will be utilized to clean the filters. A surface wash system will also be installed. Backwash pumps will be designed to provide a backwash rate of 15 gpm/$ft^2$. Water from the chlorine contact chamber will be used to backwash the filters. Provisions will also be made to utilize water from storage pond 3 for backwash water. Backwash wastewater will flow by gravity to storage pond 1. Piping will also be added so backwash wastewater can flow to the aeration pond during repair and expansion of pond 1.

| FITTING SCHEDULE | | |
|---|---|---|
| NO. | SIZE | DESCRIPTION |
| 1 | 12" | D.I.P. |
| 2 | 12" | TEE |
| 3 | 12" | 90° ELBOW |
| 4 | 12" | BUTTERFLY VALVE (ELEC. OPERATED) |
| 5 | 12"x8" | REDUCER |
| 6 | 12"x8" | TEE |
| 7 | 8" | D.I.P. |
| 8 | 8" | TEE |
| 9 | 8" | 90° ELBOW |
| 10 | 8" | 45° ELBOW |
| 11 | 8" | BUTTERFLY VALVE (ELEC. OPERATED) |
| 12 | 8" | PLUG VALVE |
| 13 | 8"x4" | REDUCER |
| 14 | 8"x4" | REDUCER (ECCENTRIC) |
| 15 | 8"x6" | TEE |
| 16 | 8"x6" | REDUCING 90° ELBOW |
| 17 | 6" | D.I.P. |
| 18 | 6" | BUTTERFLY VALVE |
| 19 | 6" | CHECK VALVE (GLOBE) |
| 20 | 11"x5" | THREADED REDUCING COMPANION FLG |
| 21 | – | PRESSURE GAUGE ASSEMBLY |
| 22 | 4" | D.I.P. |
| 23 | 4" | TEE |
| 24 | 4" | 90° ELBOW |
| 25 | 4" | BUTTERFLY VALVE (AIR) |
| 26 | 4" | CHECK VALVE (WAFFER) (AIR) |
| 27 | 4" | PLUG VALVE |
| 28 | 4" | EXPANSION JOINT (AIR) |
| 29 | 4" | FLOW METER |
| 30 | 4"x2½" | REDUCER |
| 31 | 9"x2" | THREADED REDUCING COMPANION FLG |
| 32 | 3" | CPVC PIPE |
| 33 | 3" | ALUM FILL HOSE ADAPTOR |
| 34 | 3" | 90° ELBOW |
| 35 | 3" | TANK NIPPLE |
| 36 | 3" | BALL VALVE CPVC |
| 37 | 2" | D.I.P. |
| 38 | 2" | TEE |
| 39 | 2" | 90° ELBOW |
| 40 | 2" | BUTTERFLY VALVE (ELEC. OPERATED) |
| 41 | 2" | BUTTERFLY VALVE |
| 42 | 2" | CHECK VALVE |
| 43 | 2" | GATE VALVE |
| 44 | 2"x1" | REDUCER |
| 45 | 2" | BALL VALVE CPVC |
| 46 | 2" | CPVC PIPE |
| 47 | 2" | 90° ELBOW CPVC |
| 48 | 1" | CPVC PIPE |
| 49 | 1" | BALL VALVE CPVC |
| 50 | 1" | CHECK VALVE CPVC |
| 51 | 1" | 90° ELBOW CPVC |
| 52 | 1/2" | CPVC PIPE |
| 53 | 1/2" | BALL VALVE CPVC |
| 54 | 1/2" | CHECK VALVE CPVC |
| 55 | 1/2" | 90° ELBOW CPVC |
| 56 | 1/2" | TEE CPVC |
| 57 | 1/2" | INJECTOR ASSEMBLY |
| 58 | 1/2" | PULSATION DAMPER CPVC |
| 59 | 1/2" | CALIBRATION CHAMBER CPVC |
| 60 | 1/2" | PRESSURE RELIEF VALVE CPVC |
| 61 | 1/2" | G.S.P. |
| 62 | 1/2" | TEE |
| 63 | 1/2" | 90° ELBOW |
| 64 | 1/2" | 45° ELBOW |
| 65 | 1/2" | GATE VALVE |
| 66 | 1/2" | HOSE BIBB |
| 67 | 1/2" | BACKFLOW PREVENTER ASSEMBLY |
| 68 | 2" | PLUG VALVE |




## NOTES

1. REMOVE EXISTING FIRST FLOOR WALLS AND EQUIPMENT.
2. REPLACE EXISTING EQUIPMENT AND INSTALL NEW WALLS AND CEILING IN THEIR PRIOR LOCATION EXCEPT WHERE NOTED.

**FIRST FLOOR PLAN VIEW**

SCALE: 1/8"=1'-0"

FIRST FLOOR PLAN VIEW

# WASTEWATER TREATMENT PLANT MODIFICATIONS

BIG SKY, MONTANA

FIGURE 3

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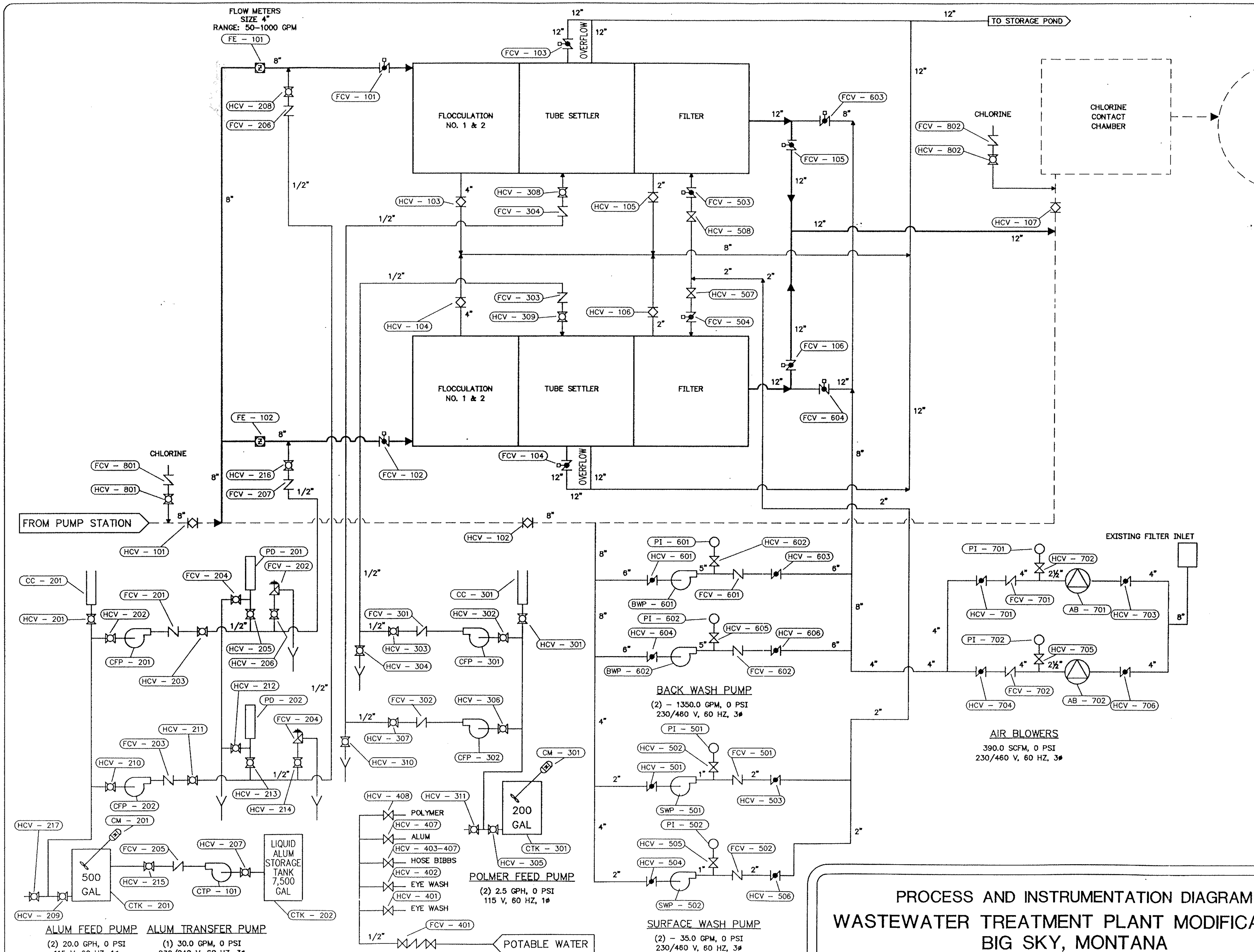


## ABBREVIATIONS

| | |
|---|---|
| AB | AIR BLOWER |
| BWP | BACKWASH PUMP |
| CC | CALIBRATION CHAMBER |
| CFP | CHEMICAL FEED PUMP |
| CTP | CHEMICAL TRANSFER PUMP |
| FCV | FLOW CONTROL VALVE |
| FE | FLOW ELEMENT |
| HCV | HAND CONTROL VALVE |
| PD | PULSATION DAMPER |
| PI | PRESSURE INDICATOR |
| SWP | SURFACE WASH PUMP |

## LEGEND

EXISTING PIPE
NEW PIPE
FLOW METER
PLUG VALVE
GATE VALVE
BUTTERFLY VALVE
PRESSURE RELIEF VALVE
BALL VALVE
CHECK VALVE
MOTOR OPERATED VALVE
PUMP
BACKFLOW PREVENTER
AIR BLOWER

FIG-4.DWG

PROCESS AND INSTRUMENTATION DIAGRAM
WASTEWATER TREATMENT PLANT MODIFICATIONS
BIG SKY, MONTANA

FIGURE 4

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## IV. LAND APPLICATION EXPANSION

### A. Golf Course Expansion

The expansion of the land application system will occur in two locations; the golf course and a 40-acre site southwest of the golf course. The irrigation system on the existing golf course will be expanded to cover the roughs and provide more complete coverage of the fairways. Exhibit 1, bound in the back, shows the limits of the irrigation expansion on the golf course. Detailed construction plans have been submitted and approved previously. The expanded irrigation system will cover 185 acres compared to the existing system which covers approximately 93 acres.

The golf course irrigation system has been designed to apply 0.17 to 0.20 inches per day during peak water use periods over the 185 acres using an application time of 6.7 hours. The application rate and application time are designed to meet the grass water requirement during a dry year. It is emphasized that the application time of 6.7 hours is needed to meet the minimum crop water requirements during a dry year. The application time can be extended to increase the volume of water disposed of while still staying below the hydraulic capacity of the soils. In calculating the irrigation capacity of the golf course we have assumed an 8-hour per day application period. This time period will dispose of additional water while still maintaining the course in a playing condition. During wet conditions, set durations will be shorter than 6.7 hours and the depth of application will normally be less than 0.17 to 0.20 inches per day. The peak application rate is well within the limiting hydraulic loading rate as determined by ring permeameter tests. Three permeameter tests were conducted on the golf course on August 28 and 29, 1995. The test locations are shown on Exhibit 1 (bound in back).

Procedures outlined in the USBR Drainage Manual were followed while conducting the ring permeameter tests. Results show that permeabilities vary from location to location. The three tests on the golf course varied greatly, depending on location. The test near hole 8's tee box (P5) indicated a permeability of over 17 inches per hour, while across the creek between hole 10 and the driving range (P4), a permeability of only 0.33 inches per hour resulted. The varying geology of the site creates this phenomenon. Near hole 8, rock terraces descend onto the golf course site, resulting in high permeability rates. The driving range and hole 10 are located on an alluvial fan created by the Crail Creek drainage. Deposition of thin layers of fine clays creates a low permeability in this location. The third test (P3) was conducted between holes 14 and 15. Permeability rates were about 3.5 inches per hour. Soil samples were taken from the top 1 foot of each permeability test location for analysis in the lab. (Appendix B)

The <u>EPA Process Design Manual Land Treatment of Municipal Wastewater</u> recommends using a design percolation rate not exceeding 4% to 10% of the minimum soil permeability. Using this criteria and the minimum observed permeability of 0.33 inches per hour results in a maximum allowable hydraulic loading rate of 0.79 inches per day. Therefore, the application rate of 0.17 to 0.20 inches per day is below the allowable hydraulic loading rate. By limiting the application rate, deep percolation of water past the root zone of the crops is minimized.

In addition to soil permeability, the allowable application rate can also be limited by nitrogen loading. The allowable application rate based on nitrogen loading has been calculated assuming a nitrogen uptake rate of 150 pounds per acre per year for Kentucky Bluegrass and a denitrification volatilization rate of 20 percent. Table 1 shows the limiting loading rate based on both hydraulic loading and nitrogen loading. Table 1 was calculated based on the procedure contained in the EPA publication referenced above.

It should be noted that while Table 1 indicates the irrigation capacity of the expanded golf course is 206 million gallons per year, in actuality the practical capacity will be far less. This is due to the fact that Table 1 is based on a 24-hour per day application rate which is not possible on a golf course. Applying an equivalent amount of water during the non-playing time would result in ponding water and soft playing conditions. In order to maintain playing conditions and irrigate at night, the actual irrigation capacity will be approximately 71 million gallons per year during the wettest year in ten. Table 2 shows the capacity calculations based on an eight-hour per day irrigation schedule.

Of the 185 acres listed in Table 2, there are approximately 40 acres of land on the driving range and other non-playing areas that could be irrigated for a longer time period. Irrigating the 40 acres for an additional 4 hour period would allow an additional irrigation volume of 7.8 million gallons. This would bring the total irrigation capacity of the golf course to 78.7 million gallons per year.

The capacity calculation of 78.7 million gallons per year represents a conservative estimate of the golf course irrigation capacity. As indicated previously, the permeability of the golf course soils varied greatly from site to site. In the actual operation of the system, it may be possible to increase the application time in areas with more permeable soils.

# TABLE 1

| BIG SKY GOLF COURSE<br>LAND APPLICATION DISPOSAL (LAD) SYSTEM<br>(Effluent applied at 15 mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 |
| Month | Days | ET (cm) | Pr (cm) | Pw (cm) | Lw(p) (cm) | U (kg/ha) | Lw(n) (cm) | HLR (cm) | HLR (in) | Acres Irrigated | Irr (MG) |
| JAN | | 0.0 | 4.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| FEB | | 0.0 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| MAR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| APR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| MAY | 12 | 1.9 | 8.8 | 9.7 | 2.7 | 7.6 | 6.3 | 2.7 | 1.1 | 185.11 | 5 |
| JUN | 30 | 7.6 | 10.0 | 24.1 | 21.7 | 31.0 | 25.8 | 21.7 | 8.5 | 185.11 | 43 |
| JUL | 31 | 10.6 | 5.8 | 24.9 | 29.7 | 43.2 | 36.0 | 29.7 | 11.7 | 185.11 | 59 |
| AUG | 31 | 9.2 | 5.6 | 24.9 | 28.5 | 37.4 | 31.2 | 28.5 | 11.2 | 185.11 | 56 |
| SEP | 30 | 3.6 | 6.3 | 24.1 | 21.5 | 14.7 | 12.3 | 12.3 | 4.8 | 185.11 | 24 |
| OCT | 3 | 0.0 | 4.6 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| NOV | | 0.0 | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| DEC | | 0.0 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| SEASON | 137 | 32.8 | 67.7 | 110.2 | 104.1 | 133.9 | 111.5 | 104.1 | 41.0 | 185.11 | 206 |

1 Growing season
2 Coolest year in 10 monthly ET value from 35 years of data at Lake Yellowstone
3 Wettest year in 10 total precipitation
4 Percolation rate (24hr/day appl. over season based on 4% of soil permeability = 0.04* 0.33 in/hr
5 Hydraulic loading rate based on soil permeability
6 Nitrogen uptake per month. (Based on 150 lbs/ac/yr (134 kg/ha/yr), proportioned to monthly ET)
7 Hydraulic loading rate based on nitrogen limits of percolation water (model assumes 15 mg/l in applied water and NO nitrates deep percolated)
8 Design hydraulic loading rate (lesser of columns 5 and 7)
9 Acreage to be irrigated
10 Allowable irrigation volume (hydraulic loading) applied to the ground surface (calculated from depth in column 8 and acreage in column 9)

# TABLE 2

**GOLF COURSE IRRIGATION SYSTEM CAPACITY**
(Effluent applied at 15 mg/l)

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Days | ET (cm) | Pr (cm) | Pw (cm) | Lw(p) (cm) | U (kg/ha) | Lw(n) (cm) | HLR (cm) | HLR (in) | Acres Irrigated | Irr (MG) |
| JAN | | 0.0 | 4.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| FEB | | 0.0 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| MAR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| APR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| MAY | 12 | 1.9 | 8.8 | 3.2 | 0.0 | 7.6 | 6.3 | 0.0 | 0.0 | 185.11 | 0 |
| JUN | 30 | 7.6 | 10.0 | 8.0 | 5.6 | 31.0 | 25.8 | 5.6 | 2.2 | 185.11 | 11 |
| JUL | 31 | 10.6 | 5.8 | 8.3 | 13.1 | 43.2 | 36.0 | 13.1 | 5.1 | 185.11 | 26 |
| AUG | 31 | 9.2 | 5.6 | 8.3 | 11.9 | 37.4 | 31.2 | 11.9 | 4.7 | 185.11 | 24 |
| SEP | 30 | 3.6 | 6.3 | 8.0 | 5.4 | 14.7 | 12.3 | 5.4 | 2.1 | 185.11 | 11 |
| OCT | 3 | 0.0 | 4.6 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| NOV | | 0.0 | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| DEC | | 0.0 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.11 | 0 |
| | | | | | | | | | | | |
| SEASON | 137 | 32.8 | 67.7 | 36.7 | 35.9 | 133.9 | 111.5 | 35.9 | 14.2 | 185.11 | 71 |

1 Growing season
2 Coolest year in 10 monthly ET value from 35 years of data at Lake Yellowstone
3 Wettest year in 10 total precipitation
4 Percolation rate (8hr/day irr. over season based on 4% of soil permeability = 0.04* 0.33 in/hr)
5 Hydraulic loading rate based on soil permeability
6 Nitrogen uptake per month. (Based on 150 lbs/ac/yr (134 kg/ha/yr), proportioned to monthly ET)
7 Hydraulic loading rate based on nitrogen limits of percolation water (model assumes 15 mg/l in applied water and NO nitrates deep percolated)
8 Design hydraulic loading rate (lesser of columns 5 and 7)
9 Acreage to be irrigated
10 Allowable irrigation volume (hydraulic loading) applied to the ground surface (calculated from depth in column 8 and acreage in column 9)

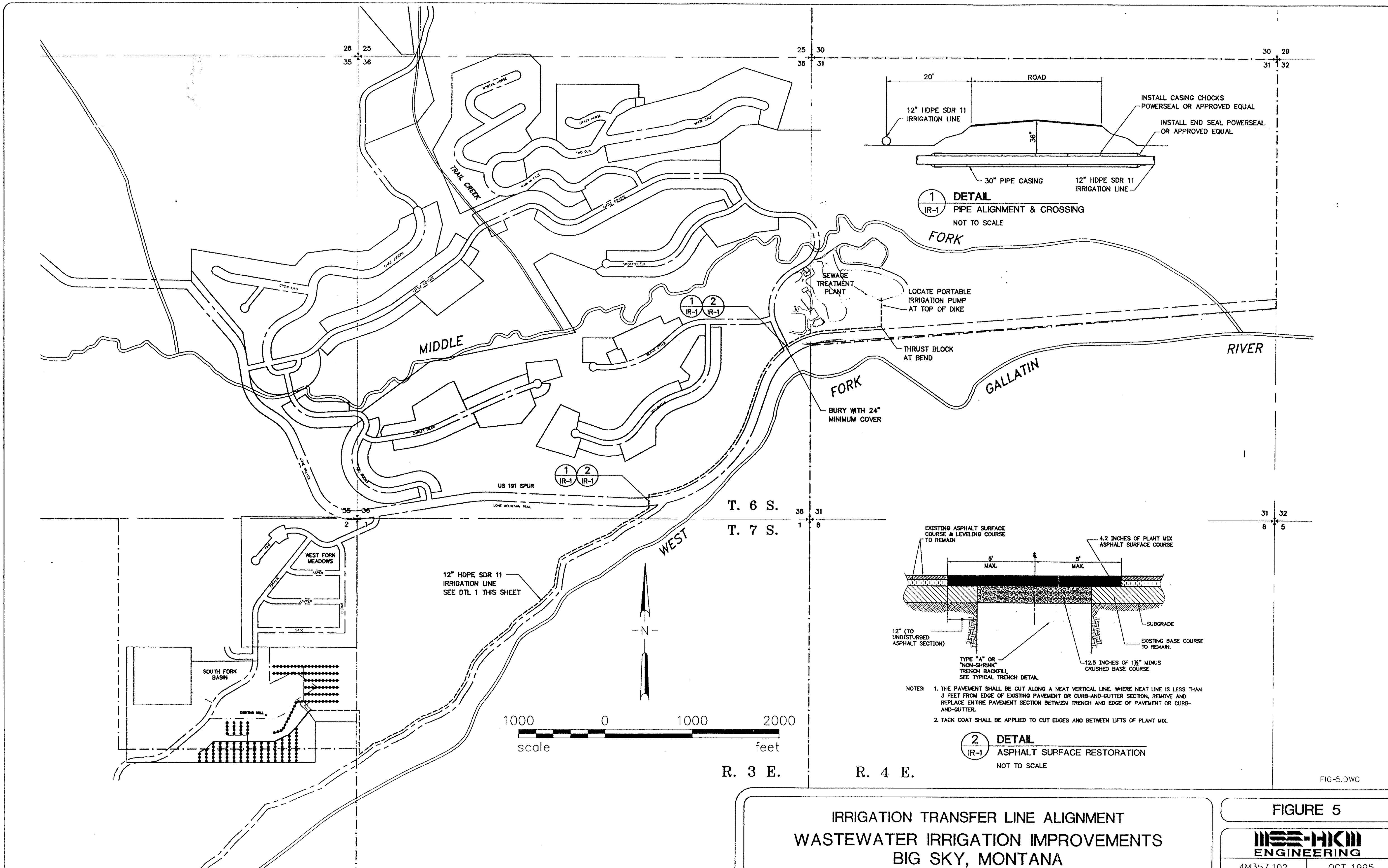
B. Temporary Remote Site Irrigation

An additional 40-acre site southwest of the golf course is included in the expansion of the land application system. Figure 5 shows the location map for this system. The irrigation system for the 40-acre site is laid out to provide 200 foot buffer zones on the west, north, east, and southeast boundaries. There is also a 200 foot buffer zone around the existing water well. The fenceline along the south border of the site was used as the boundary due to the remote nature of the area south of the project. The total irrigated area within the boundary of the system is 16.33 acres.

The irrigation system is designed to inefficiently apply irrigation water to native vegetation on the site. Vegetation consists primarily of sagebrush and wheatgrass, with a variety of other grasses. Utilizing spiral-jet nozzles that create a fine mist, the system is designed to deliver 1,200 gallons per minute out of the nozzles with very low application efficiencies. It is estimated that evaporation losses from this system will range from 40 to 50 percent of the total water delivered. Application rates at the ground surface are designed at 0.65 inches per day.

The estimated evaporation loss is based on test results from an irrigation system at Nye, MT using similar nozzles. The irrigation system at Nye, MT showed evaporation losses of 47 percent.

The irrigation schedule is planned to deliver about 44 million gallons annually to the remote site with an annual irrigation depth on the ground of about 26 million gallons. Design was based on the hydraulic loading rate criteria outlined in Table 3 and an evaporation loss of 41 percent.




IRRIGATION TRANSFER LINE ALIGNMENT

WASTEWATER IRRIGATION IMPROVEMENTS
BIG SKY, MONTANA

FIGURE 5

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The hydraulic loading spreadsheet was completed using methods set forth by EPA, similar to the golf course spreadsheet (Table 1). The percolation rate used over the growing season for the remote site was 4 percent of the minimum measured percolation rate (1.50 inches per hour), or 0.06 inches per hour. Two ring permeameter tests were completed on the 40-acre site on August 28 and 29, 1995. The soil permeabilities ranged from 1.50 inches per hour to 3.98 inches per hour. The annual design ground surface application rate of 58.4 inches per year is much less than the hydraulic loading rate allowable based on soil permeability (197 inches per year). However, nitrogen loading is the limiting factor for this case. The allowable application rate based on nitrogen loading is 58.44 inches. The nitrogen uptake rate for the site was assumed to be 200 pounds per acre per year. A denitrification volatilization rate of 20 percent was used in the spreadsheet model (Table 3). In order to achieve a nitrogen uptake rate of 200 pounds per acre per year, the irrigation area will be seeded with Garrison Creeping Meadow Foxtail. Data collected on Garrison Creeping Meadow Foxtail indicate nitrogen uptake rates up to 240 pounds per acre per year might be possible (see Appendix C).

Water will be pumped to the 40 acre site using a portable trailer mounted pump. Approximately 9400 feet of 12-inch HDPE transfer line will be laid, above ground, to the irrigation site. Chlorine will be injected at the pump site into the HDPE transfer line to provide disinfection. At a flow rate of 1200 gpm the 12-inch transfer line will provide a detention time of 34.7 minutes. A flow meter will be installed to measure irrigation flows.

To control public access at the remote site, the irrigation area will be fenced and signs will be installed to inform the public the site is being irrigated with reclaimed wastewater. To minimize problems with

# TABLE 3

## BIG SKY (40 ACRE SITE)
LAND APPLICATION DISPOSAL (LAD) SYSTEM
(Effluent applied at 15 mg/l)

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Days | ET (cm) | Pr (cm) | Pw (cm) | Lw(p) (cm) | U (kg/ha) | Lw(n) (cm) | HLR (cm) | HLR (in) | Acres Irrigated | Irr (MG) |
| JAN | | 0.0 | 4.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| FEB | | 0.0 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| MAR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| APR | | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| MAY | 12 | 1.9 | 8.8 | 43.9 | 37.0 | 10.1 | 8.4 | 8.4 | 3.30 | 16.33 | 1.46 |
| JUN | 30 | 7.6 | 10.0 | 109.7 | 107.3 | 41.2 | 34.4 | 34.4 | 13.53 | 16.33 | 6.00 |
| JUL | 31 | 10.6 | 5.8 | 113.4 | 118.1 | 57.5 | 47.9 | 47.9 | 18.86 | 16.33 | 8.37 |
| AUG | 31 | 9.2 | 5.6 | 113.4 | 117.0 | 49.8 | 41.5 | 41.5 | 16.33 | 16.33 | 7.24 |
| SEP | 30 | 3.6 | 6.3 | 109.7 | 107.1 | 19.6 | 16.3 | 16.3 | 6.42 | 16.33 | 2.85 |
| OCT | 3 | 0.0 | 4.6 | 11.0 | 6.4 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| NOV | | 0.0 | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| DEC | | 0.0 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 16.33 | 0.00 |
| SEASON | 137 | 32.8 | 67.7 | 501.1 | 492.8 | 178.1 | 148.4 | 148.4 | 58.44 | | 25.92 |

1 Growing season
2 10% probability cool year ET rate (from Lake Yellowstone)
3 Wettest year in 10 total precipitation
4 Percolation rate over the growing season (based on 4% of permeability of soil = 0.04*1.50 in/hr)
5 Hydraulic loading rate based on soil permeability
6 Nitrogen uptake per month. (Based on 200 lbs/ac/yr (178.1 kg/ha/yr), proportioned to monthly ET)
7 Hydraulic loading rate based on nitrogen limits of percolation water (this model assumes 15 mg/l in applied water and NO nitrates deep percolated)
8 Design hydraulic loading rate (lesser of columns 5 and 7)
9 Acreage to be irrigated
10 Allowable irrigation volume (hydraulic loading) applied to the ground surface (calculated from depth in column 8 and acreage in column 9)

wind drift effecting housing on the northern boundary of the irrigation site, a 200 foot setback has been provided. In addition operation procedure will provide for stopping irrigation when the wind is blowing toward the housing.

C. Pump Station Expansion

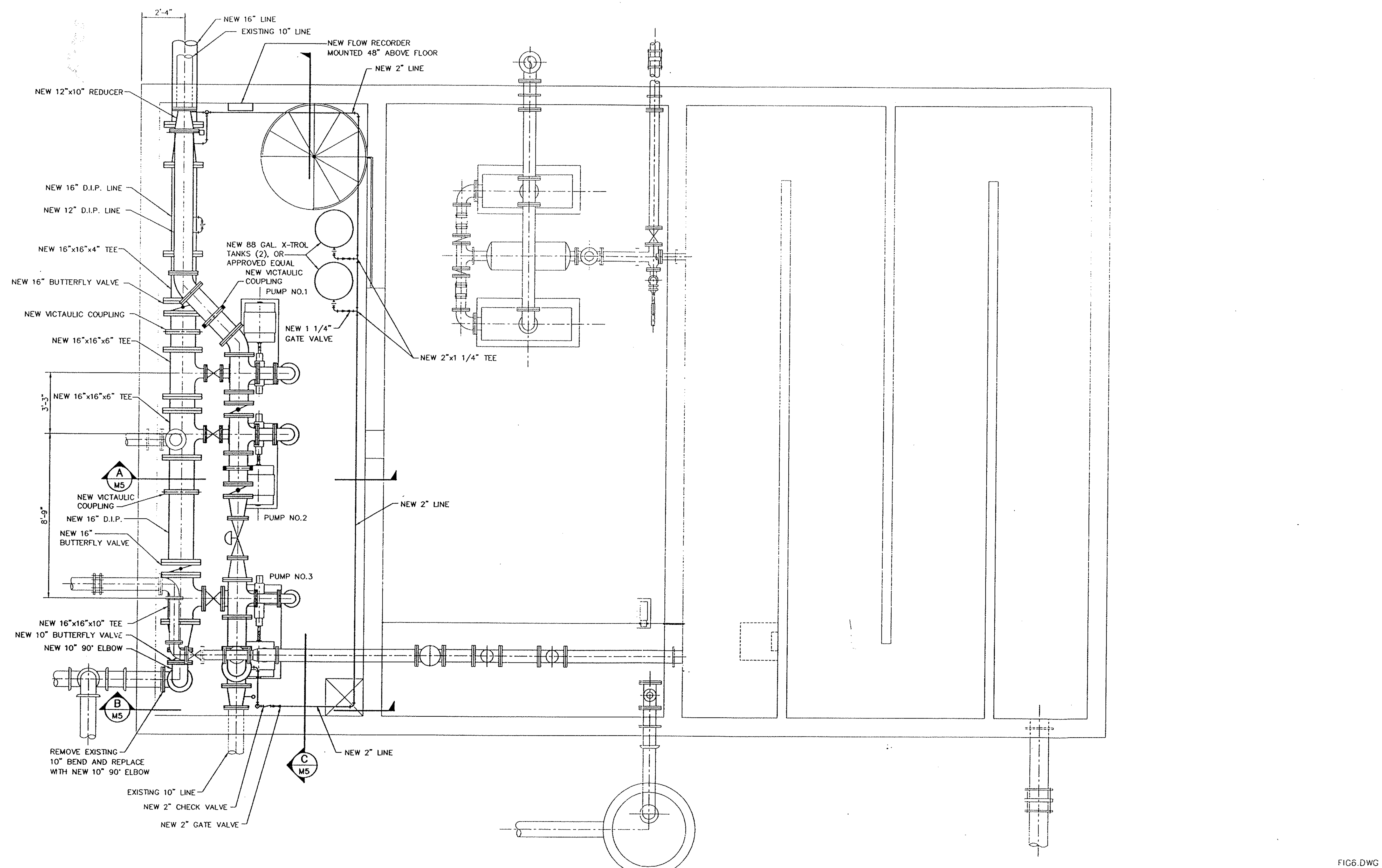
In order to expand the golf course irrigation system, the existing pump stations will be replaced to handle the increased flows. The primary booster station in the basement of the existing treatment building will be replaced with 3 new and larger variable speed pumps. Figure 6 shows the general arrangement for the pump station improvements. The primary pump station will have pumps with the following characteristics:

| | |
|---|---|
| Irrigation Pumps 1 & 2 (Variable Speed Pumps) | |
| Design Point | 1250 gpm at 280 feet |
| Motor Size | 125 HP |
| RPM | 3560 at full speed |
| Irrigation Pump 3 (Variable Speed Pump) | |
| Design Point | 1350 gpm at 178 feet |
| Motor Size | 100 HP |
| RPM | 1770 at full speed |
| Pressure Maintenance Pump | |
| Design Point | 50 gpm at 220 feet head |
| Motor Size | 7½ HP |

The variable speed pumps will be controlled by pressure transducers located on the pump discharge lines. The variable speed controller will allow the pumps to respond to the opening and closing of various irrigation zones. A pressure reducing valve is installed to allow irrigation pump 2 to act as a back-up to either pump 1 or pump 3.

A new booster station will also be constructed on the existing golf course to boost pressure on the southern loop of the irrigation system. This booster station is designed to operate in series with pump 3 in the primary booster station.

The pressure maintenance pump will maintain system pressures at low demand flows and will meet any leakage demands. The pressure tanks are designed to limit cycling of the maintenance pump.




**PLAN VIEW**

SCALE: 3/16"=1'-0"

NEW PIPING INSTALLATION

WASTEWATER IRRIGATION IMPROVEMENTS
BIG SKY, MONTANA

FIGURE 6

MSE-HKM ENGINEERING

| | |
|---|---|
| 4M357.102 | OCT 1995 |

A flow meter and recorder will be installed to measure irrigation flows to the golf course.

## V. SYSTEM CAPACITY WITH INTERIM PLAN

### A. Introduction

From July 13, 1993 to August 31, 1995 the Big Sky Sewer District 363 (previously RID 305) has been operating under a moratorium which prevented new construction from connecting to the sewer system unless it could be demonstrated that the connection would not result in an increase in $BOD_5$ loading to the state Waters (maximum annual load limit). The first amendment to the Compliance Order, issued on August 31, 1995 dropped the maximum annual load limit as a basis for allowing or disallowing new connections. The amended compliance order will allow new construction, with DEQ approval, when construction contracts for all interim improvements are awarded and financing has been finalized. To determine the capacity for additional SFE's, the expected treatment, storage and disposal capacity of the interim improvements was calculated. The following sections of this report discuss the capacity of each system component.

### B. Aerated Pond

For a land application system on an unrestricted golf course, the State's Design Standards (Circular WQB2) requires the treatment system produce an "adequately disinfected, oxidized, coagulated, clarified, filtered wastewater". An oxidized wastewater is further identified as having a minimum detention time under aeration of 15 days. Using this criteria the 8.2 MG aerated lagoon has the hydraulic capacity to treat a flow of 0.54 MGD.

In addition to the hydraulic capacity stated in the State's criteria, the EPA guidelines for water reuse on an unrestricted golf course suggest that $BOD_5$ levels be equal to or less than 30 mg/l. Using the existing $BOD_5$ influent value of 430 mg/l, the EPA partial mix model for aerated lagoons, and the plug flow model for the storage pond, the treatment performance criteria limits the capacity to approximately 0.37 MGD.

C. Flocculation/Sedimentation/Filtration System

As discussed previously in Section III, the proposed flocculation/sedimentation/filtration system is being designed based on a flow of 0.5 MGD. Two treatment trains are being provided. Each train could treat 0.5 MGD at the maximum allowable filtration rate of 5 gpm/ft$^2$. Therefore, the system will have 100 percent backup capacity for a flow of 0.5 MGD.

D. Irrigation System

The irrigation system used during the interim plan will consist of 185 acres on the existing golf course and 16.33 acres on the temporary site southwest of the golf course. The temporary site southwest of the golf course has a total area of 40 acres of which 16.33 acres is capable of being irrigated. As discussed in Section IV, the irrigation capacity of the golf course during the wettest year in 10 will be approximately 78.7 million gallons per year. It is emphasized that the irrigation capacity is limited by the recreational aspect of the golf course and not the hydraulic capacity. The hydraulic capacity, with 24-hours per day irrigation is 206 million gallons per year in the wettest year in ten. However, an application rate of 206 million gallons per year would result in saturated soil conditions that would make play difficult and most likely would result in damage to the turf grass. The fairways are seeded to Kentucky Blue Grass which have a moderate moisture tolerance. A moderate rating indicates the grass can withstand 2 to 3 days of soil saturation without crop damage.

The irrigation system on the 16.33 acres of undeveloped land will utilize a spray nozzle designed to produce a fine mist to maximize evaporation. The site has an irrigation capacity of 25.92 million gallons delivered to the ground.

It is estimated that by using the fine mist nozzles the evaporation rate will be approximately 40 to 50 percent. Therefore, for design it is estimated approximately 44 million gallons can be delivered to the site.

Based on the preceding discussion, the estimated irrigation capacity during the wettest year in 10 will be approximately 122.7 million gallons per year. Table 4 shows the projected water balance. Monthly influent flowrates wee projected based on the historical flow percentages for each month from 1988 through 1995. Table 4 assumes that the ponds are empty at the end of September and no irrigation takes place between October 1st and May 1st. Limited irrigation will occur on the remote site during May.

| TABLE 4<br>PROJECTED WATER BALANCE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MONTH | INFLUENT FLOW-MG | PREC. INCHES | EVAP.* INCHES | NET** CHANGE MG | WETTEST YEAR IN 10 GOLF COURSE IRR.-MG | REMOTE SITE IRR.-MG | STORAGE VOLUME CHANGE-MG | TOTAL STORAGE VOLUME-MG |
| January | 9.16 | 1.7 | 0.0 | 0.91 | 0.00 | 0.0 | 1.07 | 29.72 |
| February | 10.23 | 1.35 | 0.0 | 0.72 | 0.00 | 0.0 | 10.95 | 40.67 |
| March | 12.70 | 1.91 | 0.0 | 1.02 | 0.00 | 0.0 | 13.72 | 54.39 |
| April | 11.64 | 1.94 | 0.0 | 1.03 | 0.00 | 0.0 | 12.67 | 67.06 |
| May | 17.63 | 3.46 | 1.9 | 1.56 | 0.00 | -2.48 | 16.71 | 83.77 |
| June | 14.66 | 3.96 | 7.6 | -1.94 | -12.24 | -10.20 | -9.72 | 74.05 |
| July | 12.61 | 2.30 | 10.6 | -4.42 | -28.45 | -14.22 | -34.48 | 39.57 |
| August | 10.00 | 2.20 | 9.2 | -3.73 | -26.59 | -12.32 | -32.64 | 6.93 |
| September | 7.26 | 2.47 | 3.6 | -0.60 | -11.74 | -4.84 | -9.92 | 0.00 |
| October | 4.17 | 1.80 | 0.0 | 0.96 | 0 | 0.0 | 5.13 | 5.13 |
| November | 4.37 | 1.74 | 0.0 | 0.93 | 0 | 0.0 | 5.30 | 10.43 |
| December | 8.24 | 1.84 | 0.0 | 0.98 | 0 | 0.0 | 9.22 | 19.65 |
| TOTAL | 122.67 | 26.67 | | | 79.02 | 44.06 | | |

* Estimated as equal to ET rate

** Based on storage Pond Top Area of 19.63 Acres

As shown in Table 4, the maximum storage capacity required is 83.77 million gallons. Under the proposed interim plan, a storage volume of 100 million gallons will be provided.

## E. Storage Ponds

As discussed in Section II, when the improvements to the storage ponds are completed, a total storage volume of 100 million gallons will be available. With land application as the sole means of effluent disposal, the ponds must have enough volume to store water from October through May. With limited irrigation in May, the projected influent flow in May is greater than the potential irrigation volume which results in the maximum storage requirement occurring at the end of May. Based on the monthly flow distribution, the flow from October through May amounts to 63.68 percent of the total annual flow. With 100 million gallons capacity and 63.68 percent of the total flow occurring from October through May, the ponds have enough volume to provide storage for a total annual flow of roughly 157 million gallons per year assuming that the system is not limited by the land available for irrigation disposal.

## F. Conclusion

The previous sections have discussed the capacity of each of the system components in the Interim Plan. The capacities are summarized in Table 5.

| TABLE 5<br>SYSTEM COMPONENT TREATMENT AND DISPOSAL CAPACITY | |
|---|---|
| COMPONENT | TREATMENT AND DISPOSAL CAPACITY MGY |
| Aeration Ponds | 135 MGY (0.37 MGD) |
| Flocculation/Sedimentation/Filtration | 182.5 MGY |
| Irrigation System | 122.7 MGY* |
| Storage Ponds (Pond Volume = 100 MG)<br><br>* Wettest Year in 10<br>** Requires additional irrigation | 157 MGY** |

With the approval of the Revised IAWP, awarding of construction contracts, and finalized financing of the improvements, the amended compliance order makes provisions for allowing new construction. The most recent flow data available (November 1994 through October 1995) indicates the existing flow is approximately 92.7 million gallons per year. Therefore, with the minimum capacity of the proposed improvements being 122.7 MGY an additional flow of 30.0 million gallons per year could be allowed. As discussed in the June 1994 facility plan (pages 55, 85 and 87) the projected flow for new connections is 29,958 gallons per SFE per year.

**Based upon these calculations, the improvements proposed in this IAWP would allow the addition of approximately 1,000 SFE's (1001.4).**

## VI. LAND APPLICATION MANAGEMENT AND MONITORING PLAN

### A. Golf Course

#### 1. Components

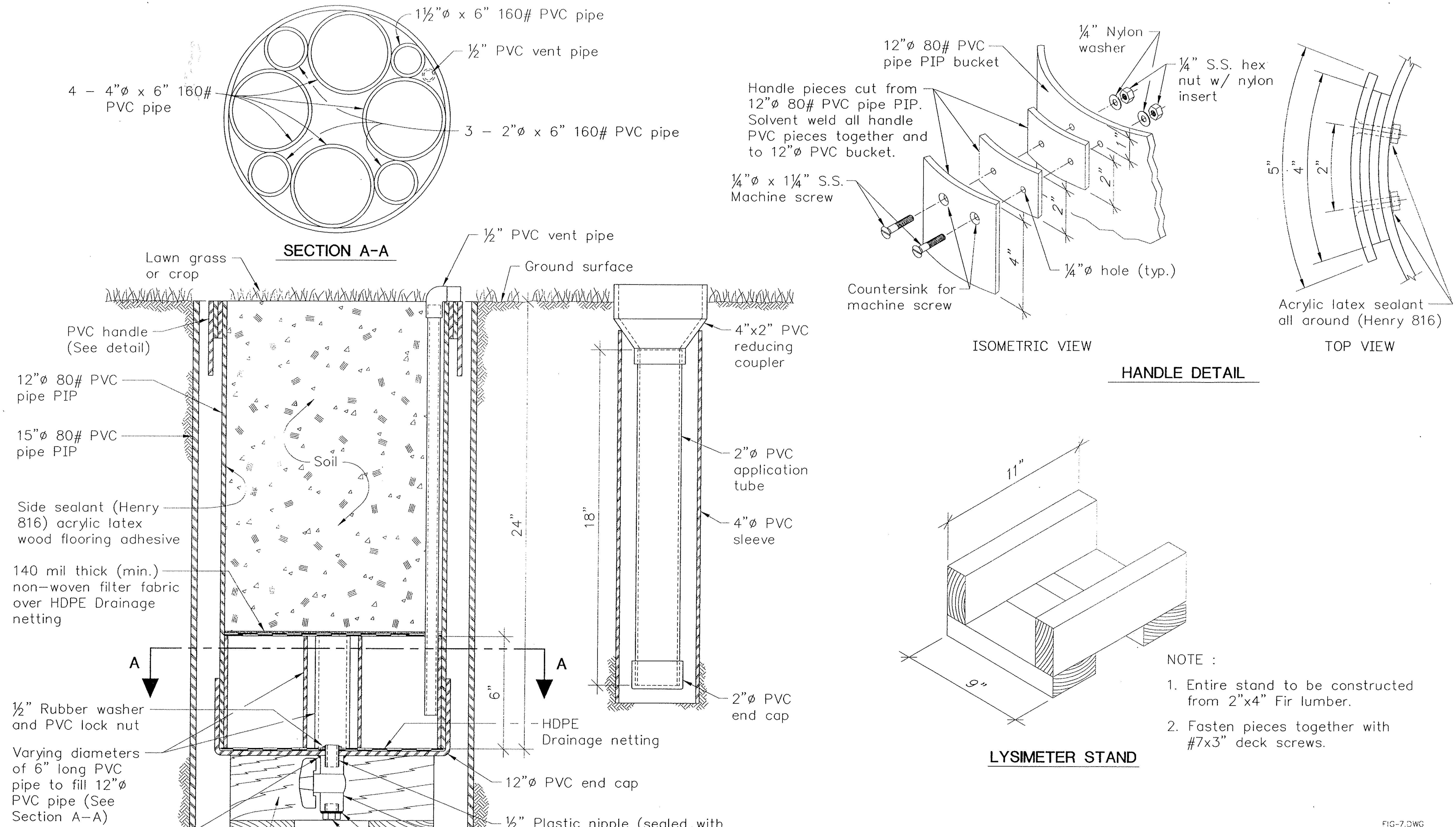
The water quality monitoring plan for the golf course was designed to examine the quantity and quality of effluent being applied and of water potentially reaching the groundwater. In secondary treated effluent, such as that being applied to the golf course at Big Sky, nitrogen is the primary nutrient that is of concern with respect to water quality. Six weighing lysimeters and six monitor wells were installed throughout the golf course in June, 1995 to monitor land application. Exhibit 1 (bound in back) shows the locations of the lysimeters and monitor wells. Each lysimeter is accompanied by a rain gage to measure the amount of water reaching the ground surface by irrigation and precipitation. Figure 7 shows details of a typical weighing lysimeter. A baseline rain gage located outside the irrigated area measures naturally occurring rainfall.

Six monitor wells were installed at various locations on the golf course to provide sample data to determine if land application of effluent on the golf course is affecting groundwater quality. The two inch inside diameter PVC monitor wells were installed to depths ranging from 16.7 to 34.4 feet.

Soil samples were collected from three lysimeter excavation holes. Grain size distribution and hydrometer test results show the top 2.5 feet of soil range from sandy lean clays to clayey gravels with sand. Clay content ranged from about 30% in the upper foot of soil to 6% in the 1.5 to 2.5 feet depth range.

#### 2. Monitoring Schedule

The monitoring schedule includes twice-monthly data collection from the lysimeters and monitor wells during the irrigation season (May through September) and monthly sampling during the non-irrigation season. Irrigation and rainfall volumes should be collected every other day or after any rainfall event exceeding 0.10 inches in depth. Frequent collection from the rain gages will minimize errors caused by evaporation in the rain gage. Written data collection procedures and several data collection spreadsheets were provided to Big Sky during the first monitoring period in July 1995. Copies of the data collection procedures and spreadsheets are attached as Appendix A.




**DETAIL OF BUCKET LYSIMETER**

FIGURE 7

MEE-HKM ENGINEERING

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## B. Temporary Remote Site

### 1. Components

The water quality monitoring plan for the remote site will consist of lysimeters and monitor wells, similar to the golf course. Three lysimeters and two monitor wells would provide thorough monitoring data for this site. Two lysimeters will be located inside the sprinkled area with one lysimeter located in the 200 foot buffer zone (near the boundary) on the east side of the site. A lysimeter in this prevailing downwind location will help quantify wind drift from the spray irrigation system. Additional rain gages in a downwind grid from the irrigated area will also quantify the wind drift from the irrigation system.

Two monitor wells, one located in the center of the irrigated area and one down gradient from the site approximately 200 feet, will show the effects of spray irrigation on the water table and on water quality.

Soil samples taken from the top foot of the profile are currently being analyzed. They were collected during field permeability tests on the 40 acre site. Additional soil samples will be taken during lysimeter installation.

### 2. Monitoring Schedule

The monitoring schedule for the remote site will be the same as the golf course monitoring schedule. Lysimeters and monitor wells will be sampled twice-monthly during the irrigation season with monthly measurements taken during the non-irrigation season. Rain gages should be measured every other day and after each significant rainfall event (greater than 0.10 inches).

## VII. SCHEDULE

A listing of the key events required in the Interim Action work plan is shown in Table 6. Exhibit 2 (bound in back) illustrates the timeline relationships between the work tasks.

| TABLE 6<br>SCHEDULE OF KEY EVENTS | |
|---|---|
| TASKS | COMPLETION DATE |
| INTERIM ACTION WORK PLAN | |
| Submit to WQD | November 1, 1995 |
| WQD Review | December 1, 1995 |
| IRRIGATION SYSTEM IMPROVEMENTS* (Pumping Facilities) | |
| Submit Plans and Specifications | October 1, 1995 |
| WQD Review | November 30, 1995 |
| Advertise for Bids | April 15, 1996 |
| Award Contract | May 1, 1996 |
| Install Piping to Remote Site | June 1, 1996 |
| Complete Golf Course Piping | September 30, 1996 |
| Complete Pump and Piping Installation | September 30, 1996 |
| FILTRATION SYSTEM IMPROVEMENTS | |
| Submit Plans and Specifications | November 1, 1995 |
| WQD Review | December 31, 1995 |
| Obtain Approval to Bid | February 10, 1996 |
| Advertise for Bids | March 15, 1996 |
| Award Contract | April 30, 1996 |
| Filter Delivery | August 30, 1996 |
| Filter Installation | November 30, 1996 |
| Filtration System Start-up | November 30, 1996 |
| STORAGE POND IMPROVEMENTS | |
| Submit Plans and Specifications | October 1, 1995 |
| WQD Review | November 30, 1995 |
| Obtain Approval to Bid | January 31, 1996 |
| Advertise for Bids | March 15, 1996 |
| Award Contract | April 30, 1996 |
| Pond 3 Construction | September 30, 1996 |
| Pond 1 Construction | October 30, 1997 |
| Pond 2 Construction | October 30, 1997 |

* Golf Course Irrigation Previously Approved on 9/20/95

## VIII. COST ESTIMATES AND FINANCING

Table 7 shows the cost estimates for the various phases of the IAWP.

A variety of financing mechanisms are currently being explored by the District. Consideration is being given to the SRF program, utilization of resort tax proceeds, INTERCAP program, and a combination of these and other options. If a bond election is necessary it could be held no sooner than April 2, 1996. The District will keep the WQD apprised of the financing choices.

TABLE 7
OPINION OF PROBABLE COST

| ITEM | UNITS | QUANTITY | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **FILTER IMPROVEMENTS** | | | | |
| Demolition | L.S. | 1 | $ 25,000 | $ 25,000.00 |
| Filter Tanks with Media | L.S. | 1 | $500,000 | 500,000.00 |
| Backwash Pumps | Each | 2 | $15,000 | 30,000.00 |
| Surface Wash Pumps | Each | 2 | $4,000 | 8,000.00 |
| Blowers | Each | 2 | $6,000 | 12,000.00 |
| Alum Tank | Each | 1 | $10,000 | 10,000.00 |
| Chemical Feed System | Each | 4 | $1,500 | 6,000.00 |
| Chlorine Scrubber | L.S. | 1 | $35,000 | 35,000.00 |
| Crane Hoist | Each | 1 | $10,000 | 10,000.00 |
| Building Structure | S.F. | 3,800 | $40 | 152,000.00 |
| Electrical & HVAC | L.S. | 1 | $75,000 | 75,000.00 |
| Process Piping | L.S. | 1 | $50,000 | 50,000.00 |
| New Building Slab | C.Y. | 60 | $350 | 21,000.00 |
| Outside Piping - 18-inch | L.F. | 495 | $50 | 24,750.00 |
| Manholes with Covers | Each | 3 | $2,000 | 6,000.00 |
| | | | SUBTOTAL | $964,750.00 |

| TABLE 7<br>OPINION OF PROBABLE COST | | | | |
|---|---|---|---|---|
| ITEM | UNITS | QUANTITY | UNIT COST | TOTAL COST |
| **PUMP STATION IMPROVEMENTS** | | | | |
| Irrigation Pumps | Each | 3 | $16,500 | $49,500.00 |
| Pressure Maintenance Pumps | Each | 1 | $7,500 | $7,500.00 |
| 16-inch BFV | Each | 4 | $2,600 | $10,400.00 |
| Manhole | Each | 1 | $2,500 | $2,500.00 |
| 10-inch G.V. | Each | 3 | $2,400 | $7,200.00 |
| 12 x 10 Reducer | Each | 3 | $750 | $2,250.00 |
| 16-inch Suction Piping (exterior) | L.F. | 260 | $45 | $11,700.00 |
| 16-inch Tee | Each | 4 | $1,600 | $6,400.00 |
| 16-inch Bends All Angles | Each | 3 | $1,100 | $3,300.00 |
| 12-inch BFV | Each | 2 | $1,400 | $2,800.00 |
| 12-inch Pressure Reducing Valve | Each | 1 | $3,000 | $3,000.00 |
| 6-inch Gate Valve | Each | 1 | $960 | $960.00 |
| 8-inch Gate Valve | Each | 2 | $1,500 | $3,000.00 |
| 6-inch Check Valve | Each | 1 | $1,500 | $1,500.00 |
| 8-inch Check Valve | Each | 2 | $2,000 | $4,000.00 |
| 12-inch Tee | Each | 3 | $900 | $2,700.00 |
| 12-inch Bends | Each | 4 | $650 | $2,600.00 |
| 8-inch Bends | Each | 2 | $350 | $700.00 |
| 6-inch Bends | Each | 1 | $300 | $300.00 |
| Pressure Tanks | Each | 2 | $800 | $1,600.00 |
| Flow Meter & Recorder | Each | 1 | $12,000 | $12,000.00 |
| Electrical | L.S. | 1 | $35,000 | $35,000.00 |
| Gauges & Transmitters | L.S. | 1 | $5,000 | $5,000.00 |
| Small Piping & Valving | L.S. | 1 | $3,000 | $3,000.00 |
| Shoring and Dewatering | L.S. | 1 | $65,000 | $65,000.00 |
| | | | SUBTOTAL | $243,910.00 |

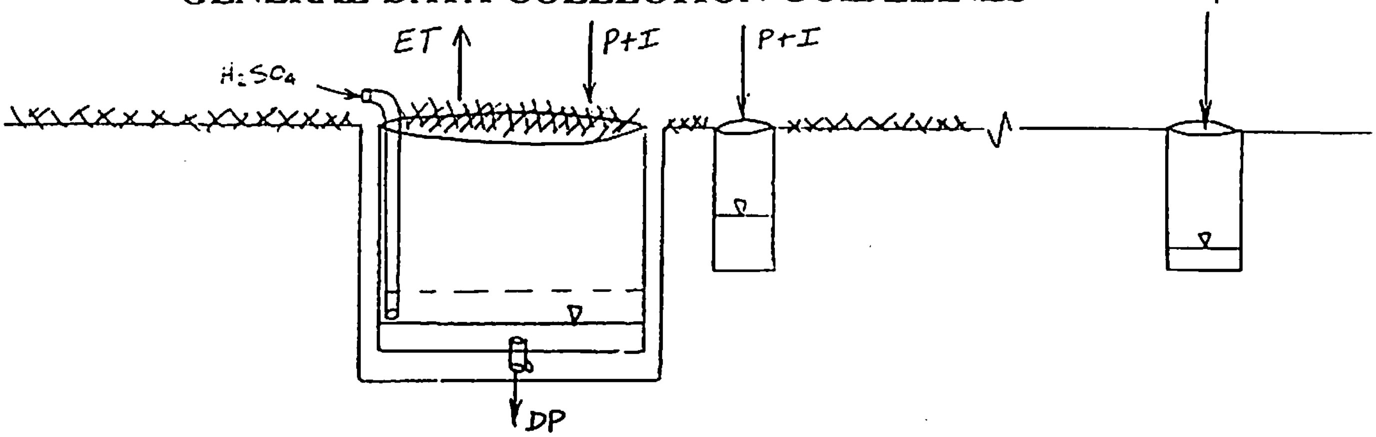
| TABLE 7<br>OPINION OF PROBABLE COST | | | | |
|---|---|---|---|---|
| ITEM | UNITS | QUANTITY | UNIT COST | TOTAL COST |
| **REMOTE SITE IRRIGATION** | | | | |
| Portable Pump & Trailer | L.S. | 1 | $25,000 | $25,000.00 |
| 12-inch HDPE - Above Ground | L.F. | 9,400 | $12 | $112,800.00 |
| 10-inch Valves | Each | 3 | $500 | $1,500.00 |
| 10-inch Surface Aluminum Pipe | L.F. | 1,450 | $7.25 | $10,512.50 |
| 8-inch Surface Aluminum Pipe | L.F. | 650 | $5.75 | $3,737.50 |
| 6-inch Surface Aluminum Pipe | L.F. | 250 | $4.00 | $1,000.00 |
| 5-inch Surface Aluminum Pipe | L.F. | 400 | $3.00 | $1,200.00 |
| 5-inch Sprinkler Pipe | L.F. | 600 | $3.50 | $2,100.00 |
| 4-inch Sprinkler Pipe | L.F. | 6,600 | $2.75 | $18,150.00 |
| 3-inch Sprinkler Pipe | L.F. | 950 | $2.00 | $1,900.00 |
| Spray Nozzles | Each | 200 | $10.00 | $2,000.00 |
| Road Crossings | Each | 2 | $25,000 | $50,000.00 |
| Seeding Cost | L.S. | 1 | $ 2,500 | $ 2,500.00 |
| Thrust Blocking | L.S. | 1 | $15,000 | $15,000.00 |
| Fencing (Farm Fence) | L.S. | 6200 | $3 | $18,600.00 |
| 2 Monitoring Wells & 3 Lysimeters | L.S. | 1 | $10,800 | $10,800.00 |
| Land costs | L.S. | 1 | $5,000 | $5,000.00 |
| | | | SUBTOTAL | $281,800.00 |
| **STORAGE PONDS** | | | | |
| Testing & Grade Staking | L.S. | 1 | $30,000 | $30,000.00 |
| Site Grubbing | Acres | 18 | $ 1,000 | $18,000.00 |
| Access Roads | Feet | 5,438 | $10 | $54,380.00 |
| Backfill, Compaction | Yard | 155,000 | $2 | $310,000.00 |
| Bedding for Liner 3/8" Minus | Yard | 11,390 | $20 | $227,800.00 |
| Yard Cut for Ponds with Hauling | Yard | 178,911 | $3.62 | $647,227.50 |

| TABLE 7<br>OPINION OF PROBABLE COST | | | | |
|---|---|---|---|---|
| ITEM | UNITS | QUANTITY | UNIT COST | TOTAL COST |
| Piping | L.S. | 1 | $47,500 | $47,500.00 |
| 40 Mil Liner for Ponds | S.F. | 923,141 | $0.40 | $369,256.40 |
| Aeration Storage Ponds | L.S. | 1 | $350,000 | $350,000.00 |
| 5' Chain Link Fence Repair | L.F. | 4,369 | $13 | $56,797.00 |
| Landscaping | L.S. | 1 | $20,000 | $20,000.00 |
| Monitoring Wells Replacement | Ea | 3 | $2,800 | $ 8,400.00 |
| Land Cost | Acre | 10 | $30,000 | $300,000.00 |
| | | | SUBTOTAL | $2,439,360.00 |
| **GOLF COURSE EXPANSION** | L.S. | 1 | $1,200,000 | $1,200,000.00 |
| | | | SUBTOTAL | $1,200,000.00 |
| | | | SUBTOTAL | $5,129,820.00 |
| | | | 15% CONTINGENCY | $769,500.00 |
| | | | CONSTRUCTION MANAGEMENT | $404,000.00 |
| | | | TOTAL | $6,303,320.00 |

# APPENDIX A

## Data Collection Procedures and Template Spreadsheets for Lysimeter Monitoring

# BIG SKY GOLF COURSE
# GENERAL DATA COLLECTION GUIDELINES




**GENERAL:**

1. Record current date of measurement.

2. Record the total gallons from flowmeter at pump.

3. Measure precipitation* from baseline rain gage in ml and convert to inches using attached chart.

Note: *Measure baseline rain gage precipitation after every significant rainfall event (P ≥25 ml or 0.10 inches).

**FOR EACH LYSIMETER:**

1. Measure precipitation plus irrigation (P+I) from rain gage at lysimeters (convert ml to inches).

2. Measure lysimeter weight prior to draining (lbs).

3. Drain lysimeter and measure deep percolation (DP) (convert ml to inches).

4. Measure lysimeter weight after draining (lbs).

5. Check to assure lysimeter weight after draining is less than lysimeter weight prior to draining. Also check that the weight of drain water ≈ Δ in measured weights.

6. Close drain valve and replace end cap on drain valve.

7. Replace lysimeter into shell.

8. Pre-preserve lysimeter with $H_2SO_4$ through vent tube. (Amount of $H_2SO_4$ added should be estimated from previous volume collected in Step 3.)

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07/20/95

# BIG SKY GOLF COURSE
# MONITORING DATA COLLECTION TEMPLATE

LYSIMETER #: ____________ DATA

| | | | |
|---|---|---|---|
| MONITORING PERIOD: | ____________ | TO | ____________ |
| PRECIPITATION + IRRIGATION: | ____________ | INCHES | (from lysimeter rain gage) |
| PREVIOUS LYSIMETER WEIGHT: | ____________ | POUNDS | (final wt. AFTER draining) |
| CURRENT LYSIMETER WEIGHT: | ____________ | POUNDS | (BEFORE draining) |
| CURRENT LYSIMETER WEIGHT: | ____________ | POUNDS | (AFTER draining) |
| DRAIN WATER WEIGHT: | ____________ | POUNDS | (Wt. before draining - Wt. after draining) |
| NITRATE CONCENTRATION OF DEEP PERCOLATED WATER: | ____________ | MG/L | (from bi-weekly INTERMOUNTAIN LAB'S results) |

# BIG SKY GOLF COURSE MONITORING SYSTEM

RAIN GAGE CONVERSION FROM MILLILITERS COLLECTED TO INCHES OF DEPTH (4.5" inside diam. raingage)

| ML | INCHES | ML | INCHES | ML | INCHES | ML | INCHES | ML | INCHES | ML | INCHES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 255 | 0.98 | 510 | 1.96 | 765 | 2.93 | 1020 | 3.91 | 1275 | 4.89 |
| 5 | 0.02 | 260 | 1.00 | 515 | 1.98 | 770 | 2.95 | 1025 | 3.93 | 1280 | 4.91 |
| 10 | 0.04 | 265 | 1.02 | 520 | 1.99 | 775 | 2.97 | 1030 | 3.95 | 1285 | 4.93 |
| 15 | 0.06 | 270 | 1.04 | 525 | 2.01 | 780 | 2.99 | 1035 | 3.97 | 1290 | 4.95 |
| 20 | 0.08 | 275 | 1.06 | 530 | 2.03 | 785 | 3.01 | 1040 | 3.99 | 1295 | 4.97 |
| 25 | 0.10 | 280 | 1.07 | 535 | 2.05 | 790 | 3.03 | 1045 | 4.01 | 1300 | 4.99 |
| 30 | 0.12 | 285 | 1.09 | 540 | 2.07 | 795 | 3.05 | 1050 | 4.03 | 1305 | 5.01 |
| 35 | 0.13 | 290 | 1.11 | 545 | 2.09 | 800 | 3.07 | 1055 | 4.05 | 1310 | 5.03 |
| 40 | 0.15 | 295 | 1.13 | 550 | 2.11 | 805 | 3.09 | 1060 | 4.07 | 1315 | 5.05 |
| 45 | 0.17 | 300 | 1.15 | 555 | 2.13 | 810 | 3.11 | 1065 | 4.09 | 1320 | 5.06 |
| 50 | 0.19 | 305 | 1.17 | 560 | 2.15 | 815 | 3.13 | 1070 | 4.11 | 1325 | 5.08 |
| 55 | 0.21 | 310 | 1.19 | 565 | 2.17 | 820 | 3.15 | 1075 | 4.12 | 1330 | 5.10 |
| 60 | 0.23 | 315 | 1.21 | 570 | 2.19 | 825 | 3.17 | 1080 | 4.14 | 1335 | 5.12 |
| 65 | 0.25 | 320 | 1.23 | 575 | 2.21 | 830 | 3.18 | 1085 | 4.16 | 1340 | 5.14 |
| 70 | 0.27 | 325 | 1.25 | 580 | 2.23 | 835 | 3.20 | 1090 | 4.18 | 1345 | 5.16 |
| 75 | 0.29 | 330 | 1.27 | 585 | 2.24 | 840 | 3.22 | 1095 | 4.20 | 1350 | 5.18 |
| 80 | 0.31 | 335 | 1.29 | 590 | 2.26 | 845 | 3.24 | 1100 | 4.22 | 1355 | 5.20 |
| 85 | 0.33 | 340 | 1.30 | 595 | 2.28 | 850 | 3.26 | 1105 | 4.24 | 1360 | 5.22 |
| 90 | 0.35 | 345 | 1.32 | 600 | 2.30 | 855 | 3.28 | 1110 | 4.26 | 1365 | 5.24 |
| 95 | 0.36 | 350 | 1.34 | 605 | 2.32 | 860 | 3.30 | 1115 | 4.28 | 1370 | 5.26 |
| 100 | 0.38 | 355 | 1.36 | 610 | 2.34 | 865 | 3.32 | 1120 | 4.30 | 1375 | 5.28 |
| 105 | 0.40 | 360 | 1.38 | 615 | 2.36 | 870 | 3.34 | 1125 | 4.32 | 1380 | 5.29 |
| 110 | 0.42 | 365 | 1.40 | 620 | 2.38 | 875 | 3.36 | 1130 | 4.34 | 1385 | 5.31 |
| 115 | 0.44 | 370 | 1.42 | 625 | 2.40 | 880 | 3.38 | 1135 | 4.35 | 1390 | 5.33 |
| 120 | 0.46 | 375 | 1.44 | 630 | 2.42 | 885 | 3.40 | 1140 | 4.37 | 1395 | 5.35 |
| 125 | 0.48 | 380 | 1.46 | 635 | 2.44 | 890 | 3.41 | 1145 | 4.39 | 1400 | 5.37 |
| 130 | 0.50 | 385 | 1.48 | 640 | 2.46 | 895 | 3.43 | 1150 | 4.41 | 1405 | 5.39 |
| 135 | 0.52 | 390 | 1.50 | 645 | 2.47 | 900 | 3.45 | 1155 | 4.43 | 1410 | 5.41 |
| 140 | 0.54 | 395 | 1.52 | 650 | 2.49 | 905 | 3.47 | 1160 | 4.45 | 1415 | 5.43 |
| 145 | 0.56 | 400 | 1.53 | 655 | 2.51 | 910 | 3.49 | 1165 | 4.47 | 1420 | 5.45 |
| 150 | 0.58 | 405 | 1.55 | 660 | 2.53 | 915 | 3.51 | 1170 | 4.49 | 1425 | 5.47 |
| 155 | 0.59 | 410 | 1.57 | 665 | 2.55 | 920 | 3.53 | 1175 | 4.51 | 1430 | 5.49 |
| 160 | 0.61 | 415 | 1.59 | 670 | 2.57 | 925 | 3.55 | 1180 | 4.53 | 1435 | 5.51 |
| 165 | 0.63 | 420 | 1.61 | 675 | 2.59 | 930 | 3.57 | 1185 | 4.55 | 1440 | 5.52 |
| 170 | 0.65 | 425 | 1.63 | 680 | 2.61 | 935 | 3.59 | 1190 | 4.57 | 1445 | 5.54 |
| 175 | 0.67 | 430 | 1.65 | 685 | 2.63 | 940 | 3.61 | 1195 | 4.58 | 1450 | 5.56 |
| 180 | 0.69 | 435 | 1.67 | 690 | 2.65 | 945 | 3.63 | 1200 | 4.60 | 1455 | 5.58 |
| 185 | 0.71 | 440 | 1.69 | 695 | 2.67 | 850 | 3.64 | 1205 | 4.62 | 1460 | 5.60 |
| 190 | 0.73 | 445 | 1.71 | 700 | 2.69 | 955 | 3.66 | 1210 | 4.64 | 1465 | 5.62 |
| 195 | 0.75 | 450 | 1.73 | 705 | 2.70 | 960 | 3.68 | 1215 | 4.66 | 1470 | 5.64 |
| 200 | 0.77 | 455 | 1.75 | 710 | 2.72 | 965 | 3.70 | 1220 | 4.68 | 1475 | 5.66 |
| 205 | 0.79 | 460 | 1.76 | 715 | 2.74 | 970 | 3.72 | 1225 | 4.70 | 1480 | 5.68 |
| 210 | 0.81 | 465 | 1.78 | 720 | 2.76 | 975 | 3.74 | 1230 | 4.72 | 1485 | 5.70 |
| 215 | 0.82 | 470 | 1.80 | 725 | 2.78 | 980 | 3.76 | 1235 | 4.74 | 1490 | 5.72 |
| 220 | 0.84 | 475 | 1.82 | 730 | 2.80 | 985 | 3.78 | 1240 | 4.76 | 1495 | 5.74 |
| 225 | 0.86 | 480 | 1.84 | 735 | 2.82 | 990 | 3.80 | 1245 | 4.78 | 1500 | 5.75 |
| 230 | 0.88 | 485 | 1.86 | 740 | 2.84 | 995 | 3.82 | 1250 | 4.80 | 1505 | 5.77 |
| 235 | 0.90 | 490 | 1.88 | 745 | 2.86 | 1000 | 3.84 | 1255 | 4.81 | 1510 | 5.79 |
| 240 | 0.92 | 495 | 1.90 | 750 | 2.88 | 1005 | 3.86 | 1260 | 4.83 | 1515 | 5.81 |
| 245 | 0.94 | 500 | 1.92 | 755 | 2.90 | 1010 | 3.87 | 1265 | 4.85 | 1520 | 5.83 |
| 250 | 0.96 | 505 | 1.94 | 760 | 2.92 | 1015 | 3.89 | 1270 | 4.87 | 1525 | 5.85 |

## DAILY DATA COLLECTION RECORD

| DAY | DATE | FLOW METER READING TO GOLF COURSE (GALLONS) | HOUR METER (HRS) | PRECIPITATION BASELINE RAINGAGE (IN) | PRECIPITATION + IRRIGATION (INCHES) LYS 1 | LYS 2 | LYS 3 | LYS 4 | LYS 5 | LYS 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 07/21/95 | | | | | | | | | |
| 2 | 07/22/95 | | | | | | | | | |
| 3 | 07/23/95 | | | | | | | | | |
| 4 | 07/24/95 | | | | | | | | | |
| 5 | 07/25/95 | | | | | | | | | |
| 6 | 07/26/95 | | | | | | | | | |
| 7 | 07/27/95 | | | | | | | | | |
| 8 | 07/28/95 | | | | | | | | | |
| 9 | 07/29/95 | | | | | | | | | |
| 10 | 07/30/95 | | | | | | | | | |
| 11 | 07/31/95 | | | | | | | | | |
| 12 | 08/01/95 | | | | | | | | | |
| 13 | 08/02/95 | | | | | | | | | |
| 14 | 08/03/95 | | | | | | | | | |
| 15 | 08/04/95 | | | | | | | | | |
| 16 | 08/05/95 | | | | | | | | | |
| 17 | 08/06/95 | | | | | | | | | |
| 18 | 08/07/95 | | | | | | | | | |
| 19 | 08/08/95 | | | | | | | | | |
| 20 | 08/09/95 | | | | | | | | | |
| 21 | 08/10/95 | | | | | | | | | |
| 22 | 08/11/95 | | | | | | | | | |
| 23 | 08/12/95 | | | | | | | | | |
| 24 | 08/13/95 | | | | | | | | | |
| 25 | 08/14/95 | | | | | | | | | |

# APPENDIX B

## Soil Analysis

HKM Associates
Engineers/Architects/Planners

# PARTICLE SIZE ANALYSIS

| TESTED BY | KM |
|---|---|
| CHK'D BY | RF |
| APPRV'D BY | RF |

PROJECT BIG SKY GOLF COURSE    PROJECT NO. 4M357.102

| LAB NO. | WT. OF SOIL (Ws) | ml. CALGON | 40 SECONDS (< 0.05 mm) TIME | TEMP °F | R | Rc | % FINER | 8 HOURS (< 0.002 mm) TIME | TEMP °F | R | Rc | % FINER | % SAND | % SILT | % CLAY | TEX. (< 2mm) | % +#10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10591 | 50.0 | 125 | 8:35:40 | 74 | 33 | 28.2 | 56 | 4:35 | 76 | 9 | 4.6 | 9 | 44 | 47 | 9 | LOAM | 16 |
| 10592 | 50.0 | | 8:37:40 | 72 | 33 | 27.8 | 56 | 4:37 | 76 | 10 | 5.6 | 11 | 44 | 45 | 11 | LOAM | 20 |
| 10593 | 50.0 | | 8:39:40 | 71 | 34.5 | 29.1 | 58 | 4:39 | 76 | 12 | 7.6 | 15 | 42 | 43 | 15 | LOAM | 12 |
| 10594 | 50.0 | | 8:41:40 | 71 | 32.0 | 26.6 | 53 | 4:41 | 76 | 12 | 7.6 | 15 | 47 | 38 | 15 | LOAM | 13 |
| 10595 | 50.0 | | 9:43:40 | 72 | 37.0 | 31.8 | 64 | 4:43 | 76 | 14 | 9.6 | 19 | 36 | 45 | 19 | LOAM | 8 |

COMMENTS

% FINER = $\frac{Rc}{Ws} \times 100$    $Rc = [R + 0.2(T - 67)] - C$    C = CALGON CORRECTION = $5 + 0.2(73-67) = 6.2$
5 @ 73°F

# APPENDIX C

## Technical Notes - Garrison Creeping Meadow Foxtail

# TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

PLANT MATERIALS NO. 12

Bozeman, Montana
March 19, 1979

RE: Garrison Creeping Meadow Foxtail, Alopecurus arundinaceus Poir, by James R. Stroh 1/ and Ashley A. Thornburg 2/

The original plants of Garrison Creeping meadow foxtail were collected near Max, North Dakota, in 1950, by Jesse McWilliams, Plant Materials Specialist, SCS. The species was brought into the area from eastern Germany or western U.S.S.R. in the early days of homesteading. The collection was evaluated at the Bismarck, North Dakota Plant Materials Center and found superior to other accessions of this species. Garrison has been under intensive evaluation in field plantings in Montana and Wyoming since 1960.

Garrison is a vigorous, long-lived perennial with aggressive sodding characteristics. Strong, thick rhizomes spread rapidly beginning in the seedling year, but it is not subject to reduced performance from sod-binding. The leaves are cauline, broad, dark green, and remain succulent throughout the growing season. For this reason, it is especially well adapted to grass-legume hay mixtures where the cutting date is determined by the maturity of the legume. Forage quality is excellent and either hay or pasture is relished by livestock.

The seed heads of this species are cylindrical, resembling timothy. The seeds of Garrison are largely black at maturity, pubescent on the lemma and palea, and have a short, bent awn. The seeds are small, light, and handle much like small feathers. Seed germination is high, averaging 90 percent. There are approximately 750,000 seed per pound. Longevity of seed kept in cool, dry storage is good. Studies show germination decreased 10 percent or less after 10 years in storage. New germination tests should be made, however, to determine seed quality before planting seed which has been stored for more than one year.

Garrison is adapted to a wide range of environmental conditions. It has been established on soils ranging in texture from silty clays to loamy sands and including peats, mucks, and gleys. Best performance in Montana and Wyoming has been on soils with neutral or acidic pH. Garrison foxtail can tolerate slightly saline (2 to 4 mmhos/cm EC 3/) to moderately saline

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1/ Formerly Plant Materials Center Manager, Bridger, Montana, now Plant Materials Specialist, Anchorage, Alaska

2/ Regional Plant Materials Specialist, MTSC, Lincoln, NE (Retired)

3/ Mmhos/cm EC = Electrical Conductivity of a soil sample--measures the total soluble salt content of the soil.

(4 to 8 mmhos/cm EC) soils which have low SAR 4/ values provided the soils are continually moist and the subsurface water is low in soluble salts. Garrison is difficult to establish from seed on even moderately saline soils with 6 to 8 mmhos/cm EC. When stands are obtained, yields are depressed when EC readings reach 8 mmhos/cm. Garrison plants can seldom live in soils having EC readings in excess of 12 mmhos/cm. Soil tests should be taken on wet saline sites before seeding is attempted to ascertain whether Garrison can be established and will grow and be productive on the site.

Successful plantings are found from 1900 feet elevation to 7500 feet. It performs well in growing seasons of 34 to 140 frost free days, being highly tolerant of late spring and early fall frosts.

The primary requirement for good plant growth is adequate soil moisture conditions throughout the growing season. Irrigated or subirrigated sites are recommended in areas with less than 25 inches annual precipitation. Plantings need not be limited to naturally wet sites. Best performance is attained on sites with high inherent or applied fertility.

Garrison foxtail is an excellent grass for hay or pasture, alone or in mixtures with a legume. It grows vigorously throughout the growing seasons if adequate soil moisture and fertility are available. It recovers rapidly from grazing or mowing. The response of Garrison to applications of nitrogen fertilizer is excellent. The results of a two-year study at Farson, Wyoming, conducted by the USDA Agricultural Research Service, show that Garrison responded to nitrogen applications better than the other creeping foxtail and meadow foxtail accessions and that the comparative response was greater at the higher rates.

| | Pounds of Actual N Per Acre | | | |
|---|---|---|---|---|
| | 0 | 80 | 160 | 240 |
| | Forage yields in tons per acre | | | |
| Garrison creeping foxtail (Alopecurus arundinaceus) | 0.4 | 2.2 | 3.8 | 5.1 |
| P-111 creeping foxtail (Alopecurus arundinaceus) | 0.5 | 2.2 | 3.2 | 3.2 |
| Meadow foxtail (Alopecurus pratensis) | 0.5 | 1.9 | 2.7 | 3.3 |

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4/ SAR = Ratio of sodium salt to calcium and magnesium salts. Low SAR values indicate that significant amounts of calcium and magnesium salts are available in the soil to buffer the effects of the sodium salt that is present. Soils with high SAR values have little calcium or magnesium salts to buffer the effects of sodium.

The response of Garrison in increments of forage produced per pound of nitrogen compared to no nitrogen was also superior.

| | Pounds of Actual N Per Acre | | | |
|---|---|---|---|---|
| | 0 | 80 | 160 | 240 |
| | Lbs. of forage per lb. of N. | | | |
| Garrison creeping foxtail | - | 45 | 43 | 39 |
| P-111 creeping foxtail | - | 43 | 34 | 23 |
| Meadow foxtail | - | 35 | 28 | 23 |

The forage increment per pound of actual nitrogen applied is a true measure of plant response and can be used to determine if applying nitrogen is economical. Normally, an increment of 25 to 30 pounds is considered the economic "break-even" point. Increments above this are economical, those below it are not.

Established stands of Garrison can be maintained indefinitely with proper management. The variety is free of insect and disease problems. It will withstand heavy grazing pressure, flooding, icing, infertility, and periods of drought, and return to full production with adequate management and climatic conditions.

Proper management of pure stands of Garrison require supplying sufficient supplementary water, if needed, to keep the soil moisture between 50 percent and full field capacity. Fertility requirements should be based on annual soil tests with the available nitrogen level at approximately 100 lbs/acre per year. This level may be increased if the response to greater amounts proves economical. Grazing practices should follow established procedures with rotation grazing systems being most suitable.

It is recommended that when planting Garrison with a legume for either pasture or hay the grass be seeded in alternate rows with the legume. The legume selected should be adapted to the site. In grass-legume mixtures the planting must be managed for the legume to keep the desirable quantity of legume in the mixture.

A firm, moist, weed-free seedbed is essential for the establishment of Garrison. Seedling vigor is weak until the secondary roots become established. Successful establishment has been obtained with early spring or late fall seedings (after October 15). The recommended seeding rate is three pounds of pure live seed per acre, or 50 PLS per square foot planted not more than 1/2 inch deep. The light, fluffy seed should be mixed with rice hulls in the proportion of three pounds of pure live seed to 20 pounds (2 bushels) of rice hulls to facilitate seeding through a grain drill. The drill is then calibrated to provide 50 live seed per square foot. No fertilizer need be applied at the time of seeding. Do not graze the stand in the seedling year.

Van K Haderlie
Van K Haderlie
State Conservationist

Distribution: AFL
PT Specialists
Regional Plant Materials Specialist, WTSC, Portland.

FILE: Reference File - Plant Materials

USDA-SCS-MONT 3-19-79

Golf Course
IRRIGATION AREA

END

BOUNDARY OF NEW
IRRIGATION SYSTEM

BOUNDARY OF EXISTING
IRRIGATION SYSTEM

ILL HOLE NUMBER FOR GROUNDWATER MONITORING

SIMETER NUMBER

RMEAMETER TEST LOCATIONS

ARIES ARE NOT TO SCALE
POSE IS FOR SHOWING LOT OWNERSHIP

DOES NOT REPRESENT A SURVEY.
ASSUMED AS TO THE
THE DATA DELINEATED HEREIN.

ENGINEERING

# LEGEND

BOUNDARY OF NEW IRRIGATION SYSTEM

BOUNDARY OF EXISTING IRRIGATION SYSTEM

DH-1 DRILL HOLE NUMBER FOR GROUNDWATER MONITORING

L1 LYSIMETER NUMBER

P3 PERMEAMETER TEST LOCATIONS

LOT LINE BOUNDARIES ARE NOT TO SCALE
THEIR ONLY PURPOSE IS FOR SHOWING LOT OWNERSHIP

DISCLAIMER

THIS DRAWING DOES NOT REPRESENT A SURVEY.

NO LIABILITY IS ASSUMED AS TO THE ACCURACY OF THE DATA DELINEATED HEREIN.

HKM ENGINEERING

# EXHIBIT 2

# INTERIM ACTION WORK PLAN SCHEDULE

ENGINEERING

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