Print Form

Engineering Review Transmittal Form

Consultant/Engineer: Review this revised transmittal and complete all sections applicable to this project submittal. Return a completed form with each submittal made to DEQ for review. Failure to include this fully completed form may result in a delay of project review.

Submittal date: 6-12-2018

Project title: City of Spirit Lake Wastewater Facility Plan

City: Spirit Lake County: Kootenai Zip code: 83869

Water purveyor: City of Spirit Lake Will serve? ☐ Yes ☒ NA

Sewer purveyor: City of Spirit Lake Will serve? ☐ Yes ☒ NA

Consulting firm: James A. Sewell & Associates, LLC

Engineer: Kevin Koesel, P.E. Engineer's email: kkoesel@jasewell.com

Owner/developer: City of Spirit Lake

Contact name: Mayor Renee Eastman

Owner's address: 6042 West Maine, Street

City: Spirit Lake State: ID Zip code: 83869

Phone: 208-623-2131 Owner's email: Mayor18@spiritlakeid.gov

Review type: Resubmittal

Submittal description: Facility plan

Project types:

Wastewater: Treatment plant/nonNPDES

Drinking water:

Solid waste/landfill:

Reuse (municipal) (WRU-M):

JAMES A. SEWELL & ASSOCIATES, LLC
600–4th Street West
Newport, Washington 99156
(509) 447-3626
(208) 437-2641
(509) 447-2112 Fax

*Civil Engineering * Electrical Engineering * Land Surveying * Building Inspection * Land Use Planning

June 12, 2018

Idaho Department of Environmental Quality
2110 Ironwood Parkway
Coeur d'Alene, ID 83814

Attn: Craig M Borrenpoh, P.E. MPA
Subj: City of Spirit Lake Wastewater Facility Plan
Ref: Facility Plan Resubmittal for Review

Dear Craig:

Enclosed please find the City of Spirit Lake Wastewater Facility Plan resubmittal for your review and approval. The Facility Plan has been revised based on comments from you dated May 8, 2018 and comments received from the project funding agency, USDA Rural Development. The five regulator comments noted by DEQ have been addressed as follows:

Comment 1 – Groundwater Monitoring

A groundwater monitoring plan that consists of three groundwater monitoring wells was prepared and included in Appendix D-2. The proposed plan was prepared by John Monks of Monks Hydro-Geoscience and includes well locations, construction details and proposed sampling constituents and frequencies for DEQ review and approval.

Comment 2 – Proposed Lagoon Cell No. 5 Setbacks

IDAPA 58.01.16 Section 450.01.c identifies the requirements for lagoon setbacks. The facility plan has been revised to note how the proposed Lagoon Cell No. 5 will meet those setbacks on page 52 - item 2, paragraph 6.

Comment 3 – Average Annual Wastewater Flow per ERU

Table 14 on page 45 of the Facility Plan shows the background data for the average annual flow per day per equivalent residential unit. This value was determined by taking the total influent for the year and dividing it by the number of ERUs served for that year to determine the average flow per ERU.

Comment 4 – Chlorine Contact Disinfection Improvement Preliminary Engineering Report

This comment is somewhat confusing because it requests a preliminary engineering report be submitted prior to construction of improvements to the chlorine contact system. Previously construction plans for the Chlorine Contact Pipe Addition project were approved for construction by DEQ on July 26, 2017.

Comment 5 – Existing Lagoon Cells 1, 2 and 3 Liners

Additional discussion as to the condition of the existing liners in Lagoon Cells 1, 2, and 3 has been added on page 36 of the Facility Plan.

Your review of the enclosed information would be much appreciated. Please contact me with any questions at 509-447-3626 or kkoesel@jasewell.com.

Sincerely,

JAMES A. SEWELL & ASSOCIATES, LLC

By Kevin Koesel
Kevin Koesel, P.E.

Encl:
pc: City of Spirit Lake, Renee Eastman, Ann Clapper & Luke Eastman – 2 copies
File w/ encl

JAMES A. SEWELL & ASSOCIATES, LLC

600–4th Street West
Newport, Washington 99156
(509) 447-3626
(208) 437-2641
(509) 447-2112 Fax

*Civil Engineering * Electrical Engineering * Land Surveying * Building Inspection * Land Use Planning

June 12, 2018

USDA Rural Development
7830 Meadowlark Way, Suite C3
Coeur d'Alene, ID 83815

Attn: Howard R. Lunderstadt, Community Programs Specialist
Subj: City of Spirit Lake Wastewater Facility Plan
Ref: Facility Plan Resubmittal for Review

Dear Howard:

Enclosed please find the City of Spirit Lake Wastewater Facility Plan resubmittal for your review and approval. The Facility Plan has been revised to reflect comments by DEQ and USDA Rural Development. The following USDA comments from February 12, 2018 have been addressed:

Item 1 – Table 11, Define Standby User, Page 42.
Item 2 – Table 13, Provide Discussion for Commercial versus Residential Flow, Page 43.
Item 3 – Discuss Future Growth versus Historic Growth, Page 46.
Item 4 – Provide Discussion on Mechanical Treatment Plant Option, Page 57.
Item 5 – Provide Discussion on Surface Water Discharge Option, Page 58.
Item 6 – Provide Step by Step Plan and Timeframe for Improvements, Page 103.
Item 7 – Explain Short Lived Asset Reserve Requirements, Page 98.

Your review of the enclosed information would be much appreciated. Please contact me with any questions at 509-447-3626 or kkoesel@jasewell.com.

Sincerely,

JAMES A. SEWELL & ASSOCIATES, LLC

By ______________________________
Kevin Koesel, P.E.

Encl:
pc: City of Spirit Lake, Renee Eastman, Ann Clapper
File

City of Spirit Lake
Spirit Lake, Idaho

WASTEWATER FACILITIES PLAN FOR THE CITY OF SPIRIT LAKE, IDAHO

JUNE, 2018 Revised

Prepared by:

James A. Sewell and Associates, LLC

600 4th Street West
Newport, WA 99156
(208) 437-2641
(509) 447-2112 fax

14712
KEVIN KOESEL

Kevin Koesel

6-12-'18

WASTEWATER FACILITY PLAN 2017
For the
CITY OF SPIRIT LAKE, IDAHO

A. Introduction

1. *Purpose and Need*

The City of Spirit Lake wastewater system includes a gravity collection system serving the majority of town, four sewage lift stations, and a wastewater treatment/disposal system. The wastewater treatment/disposal system is a land based system consisting of four lagoon cells and five land application/wastewater reuse application fields.

The City has experienced significant growth over the past several years, and as a result the existing treatment/disposal facility is near or at its capacity limits. The wastewater treatment/disposal system currently has three distinct areas of deficiencies which include: lagoon storage, wastewater treatment capacity, and land application area. The City has been actively planning and constructing improvements to each of these deficiency areas; however, recent rapid growth has consumed the City's reserve capacity. Over the past year, under DEQ approval, the City has operated with a one-time temporary permit allowing irrigation application in excess of the calculated irrigation water requirements in order to mitigate overfilling of their lagoon cells during the upcoming winter storage season. This Facility Plan outlines improvements to mitigate the lagoon storage shortage, increase efficiencies for the irrigation land application system, and improvements to enhance the plant biological treatment process.

2. *Owner Responsibility*

The City of Spirit Lake has retained the services of James A. Sewell and Associates, LLC (JAS) for all design and project management duties. JAS has successfully designed and managed many projects of similar size and scope for over 50 years. The City of Spirit Lake contracts with an outside accounting firm to prepare the financial records for the City of Spirit Lake in preparation of audits. Under the supervision of the City and the accounting firm, the City of Spirit Lake has found no issues related to their financial audits.

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B. Existing Conditions within the Project Planning Area

1. Project Planning Area/Location

The boundaries of the overall project planning area include the boundaries of the City of Spirit Lake and the boundaries of the City's wastewater treatment/disposal facility. The project planning area and area of potential effect are located Township 53 North, Range 4 West, Boise Meridian, portions of Sections 5, 6, 7, and 8 and also Section 31 of Township 54 North, Range 4 West. The wastewater system study area includes the wastewater treatment/disposal system located approximately one (1) mile north of the City of Spirit Lake and the existing sewer collection system serving the developed areas within the City as shown in Figure 1 - Google Earth Image of Proposed Project Planning Area., Figure 2 - Proposed Project Planning Area and Area of Potential Effect., and Figure 3 - Quad map of the City of Spirit Lake. Township 53 North, Range 4 West, Boise Meridian, portions of Sections 5, 6, 7, and 8., and Figure 4 - Quad map of the City of Spirit Lake WWTP. Township 54 North, Range 4 West, Boise Meridian, portions of Section 31.

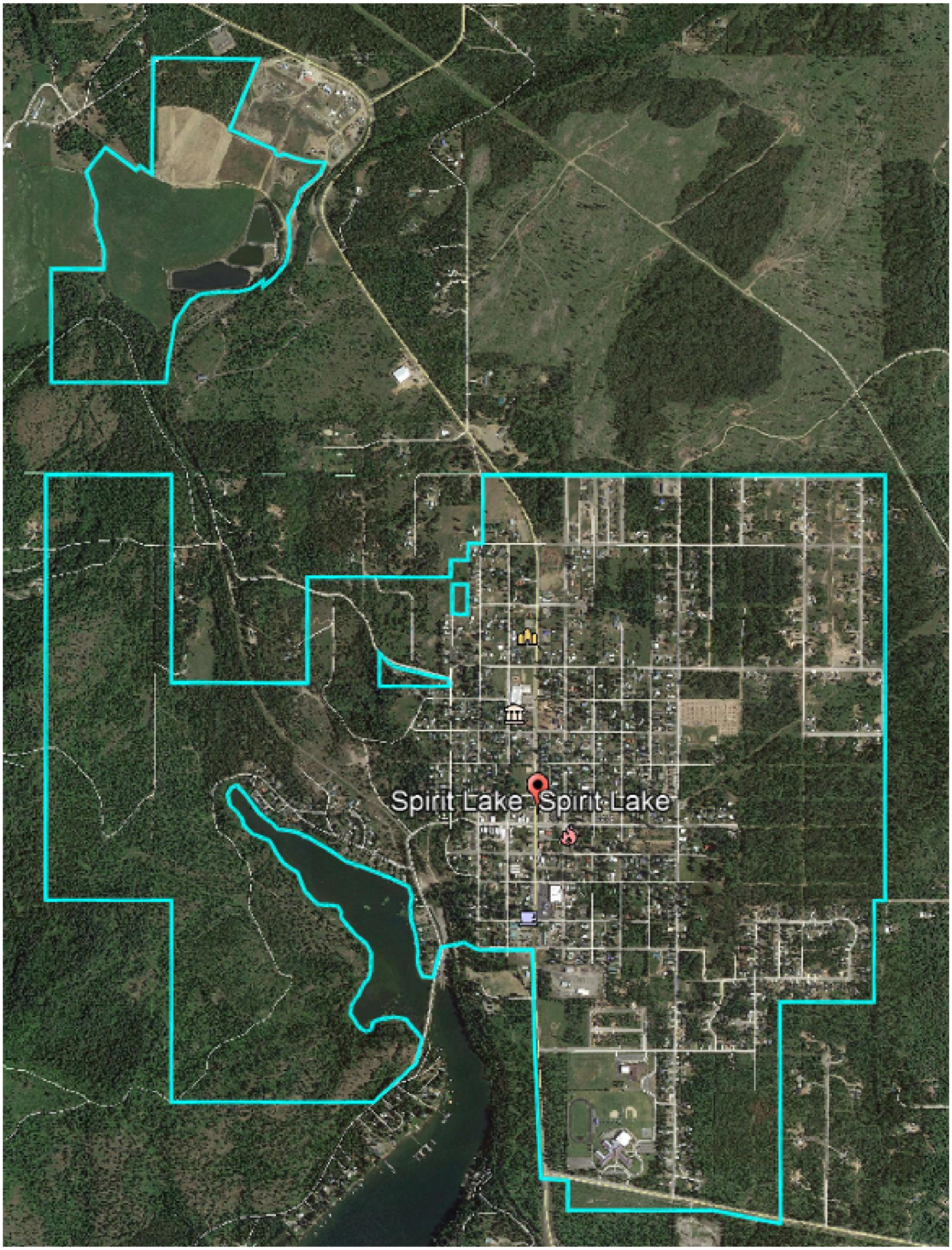

Figure 1 - Google Earth Image of Proposed Project Planning Area.

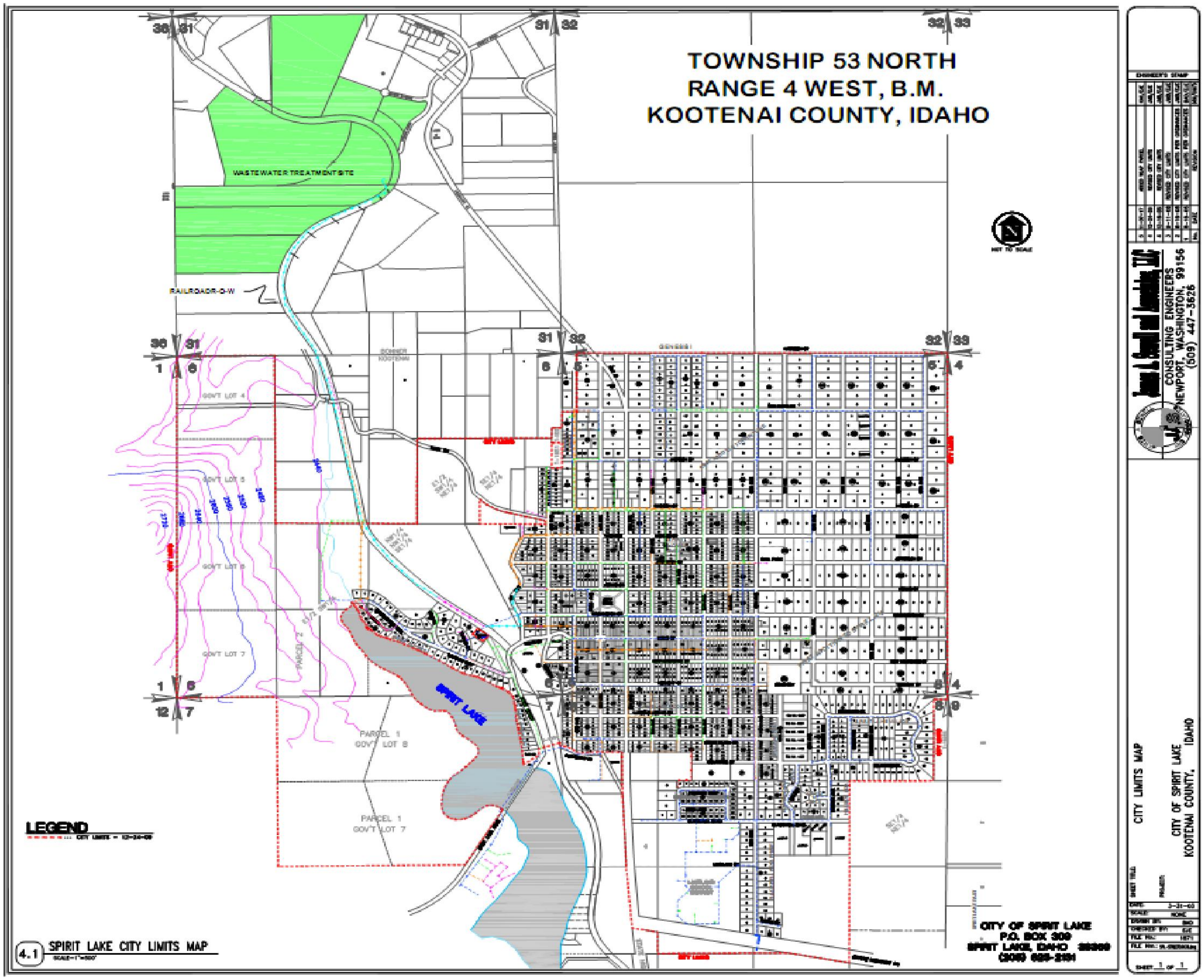

Figure 2 - Proposed Project Planning Area and Area of Potential Effect.

2. Existing Environmental Conditions

A) TOPOGRAPHY, GEOLOGY

The topography within the City is typically flat with some moderately steep slopes around the City's namesake, Spirit Lake, see Figure 3 - Quad map of the City of Spirit Lake. Township 53 North, Range 4 West, Boise Meridian, portions of Sections 5, 6, 7, and 8. The majority of the City is located on a bench above Spirit Lake at an approximate elevation of 2570' above sea level. On the west side of the City, the land slopes down to Spirit Lake which is at an approximate elevation of 2440' above sea level. The majority of the populated areas within Spirit Lake are located on the bench above the lake. The wastewater collection system is primarily gravity collection with four wastewater lift stations. The treatment/disposal facility is located at an approximate elevation 2370, and wastewater is transmitted to the treatment plant via a gravity transmission line.

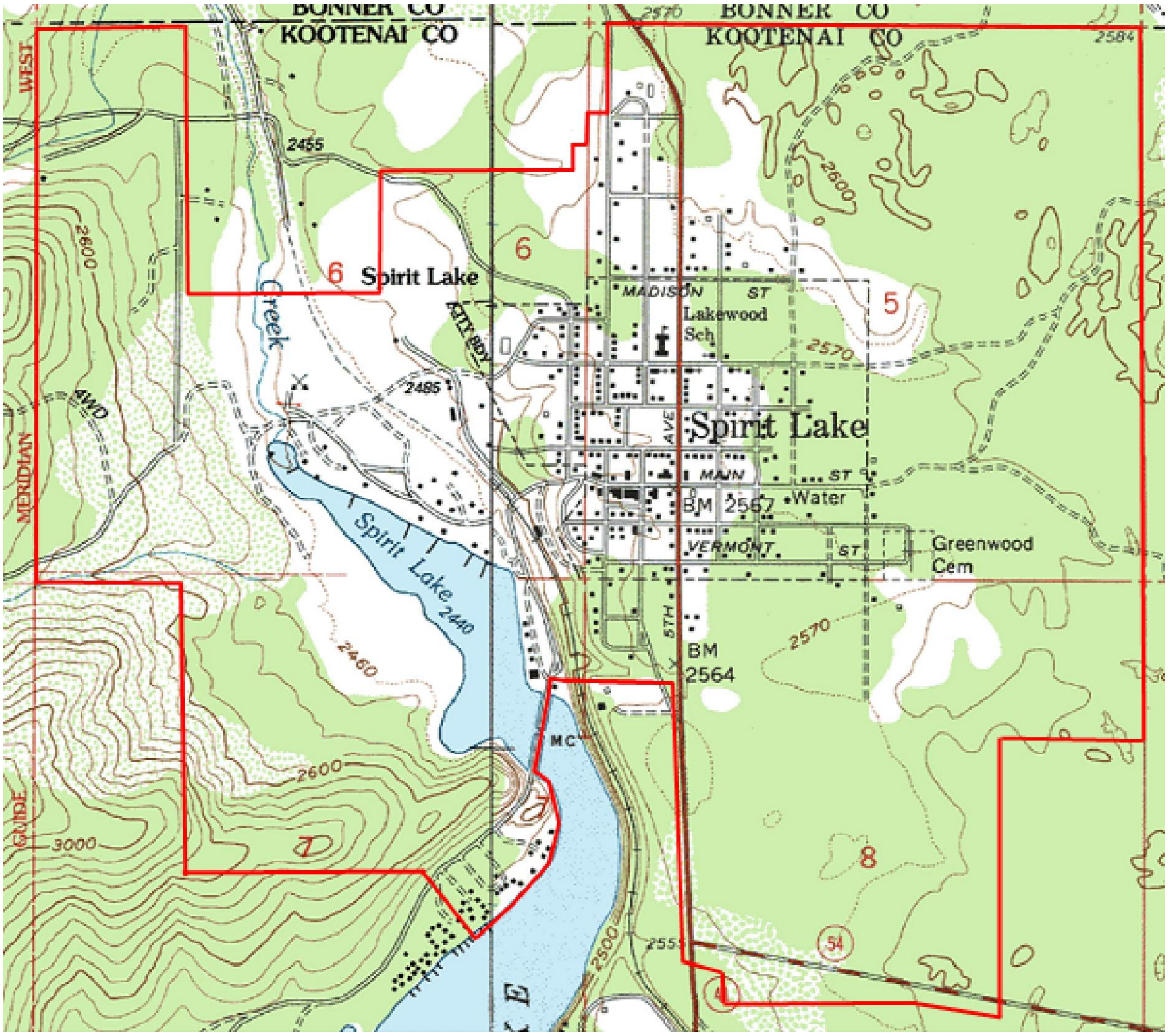

Figure 3 - Quad map of the City of Spirit Lake. Township 53 North, Range 4 West, Boise Meridian, portions of Sections 5, 6, 7, and 8.

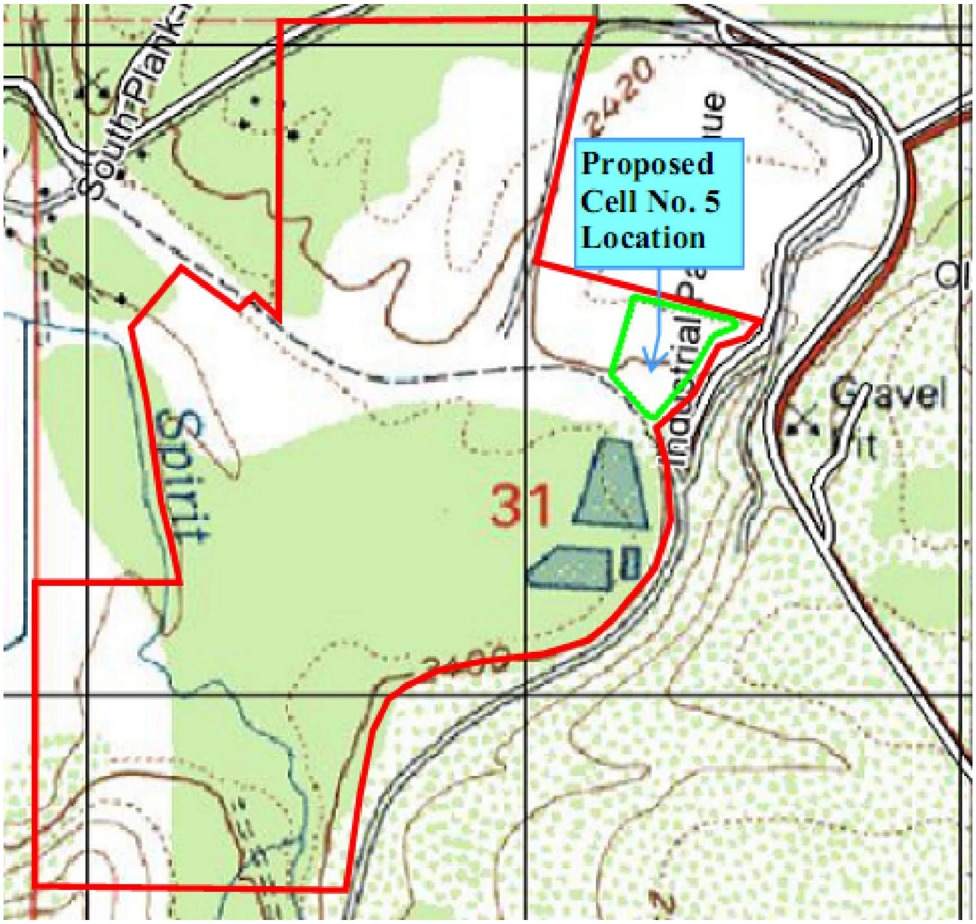

Figure 4 - Quad map of the City of Spirit Lake WWTP. Township 54 North, Range 4 West, Boise Meridian, portions of Section 31.

According to the Natural Resources Conservation Service (NRCS), the surface soils within the City consist mainly of silt loams with areas of gravelly silt loams. Figure 5 shows the soils map produced by the NRCS. The soil descriptions for each identified soil can be found in Appendix B-1. The differing soil types are designated by the orange lines and their soil identification numbers. Approximately 38% of the City contains soil type Kootenai-Bonner complex, 0-20 percent slopes (#129). The majority of the developed area of the City contains this soil type. Approximately 18% of the City contains soil type Kootenai-Rathdrum association, 0-20 percent slopes (#130). Much of the undeveloped area on the west side of the City contains this soil type. Both of these soil types are gravelly silt loams. Approximately 16% of the City contains soil type McGuire-Marble association, 0-7 percent slopes (#149). This soil type is a sandy loam soil and dominates the undeveloped area on the northwest portion of the City. The remainder of the soils within the City contains various forms of sandy loams and silt loams. In general, the native soils are suitable for pipeline construction. Pipe bedding material can be generated onsite through screening to remove large rocks and cobbles. A review of area well logs within and near the City limits indicates that deeper soils consist mainly of gravelly silts and sands with occasional areas of clay.

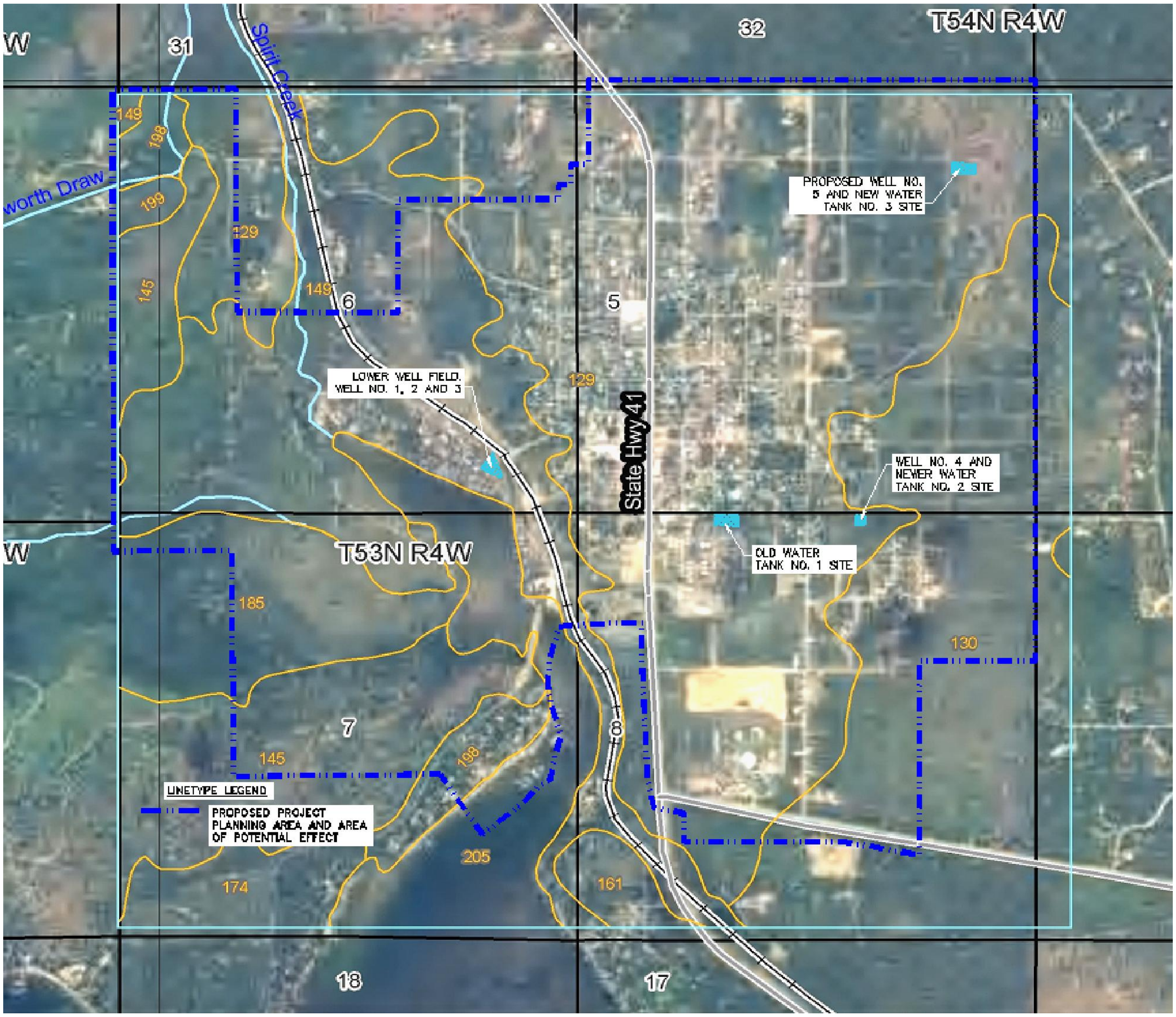

Figure 5 - NRCS soil map, see Appendix B-1 for soil descriptions.

The NRCS soil types that occur within the land application area are shown in Figure 6.

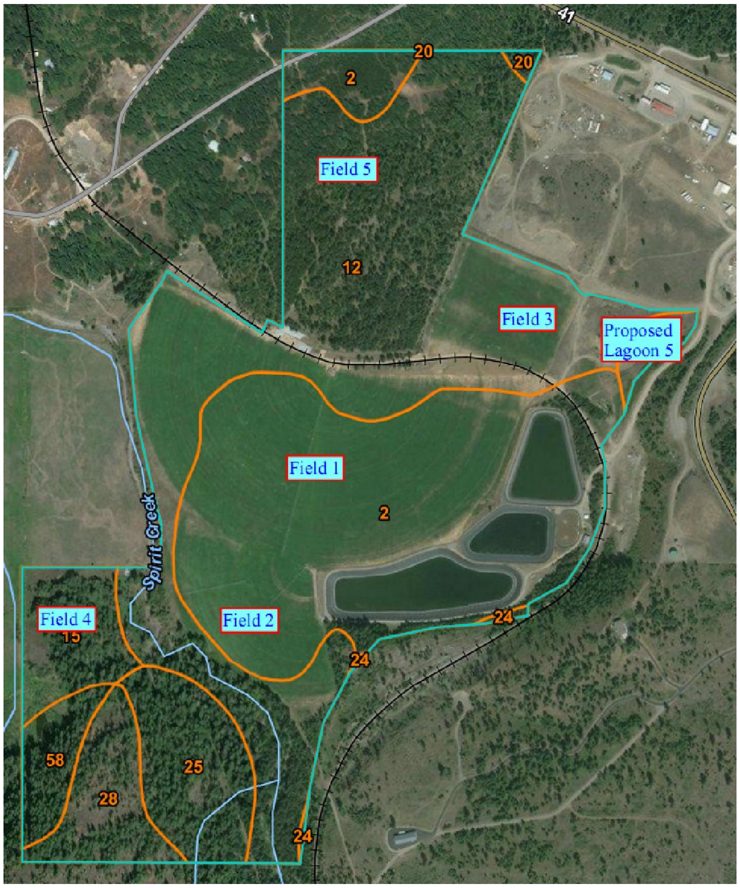

Figure 6 – NRCS soil map, see Appendix B-2 for soil description.

Soil Type 2: Bonner gravelly silt loam
Soil Type 12: Elmira loamy sand
Soil Type 15: Hoodoo silt loam
Soil Type 24: Kootenai gravelly silt loam
Soil Type 25: Kootenai-Bonner gravelly silt loam
Soil Type 28: Lenz-Rock outcrop association
Soil Type 58: Vasser silt loam

The majority of Fields No. 1 and No. 2 are composed of Bonner gravelly silt loam. The northern portion of Field 1 as well as Fields 3 and Field 5 contain Elmira loamy sand. Field no. 4 is a forest area and consists of Hoodoo silt loam split with Elmira loamy sand and Kootenai-Bonner gravelly silt loam. The areas noted on the soils map containing Lenz-Rock outcrop association and Vasser silt loam are not utilized for wastewater treatment. One of the proposed improvements will be the addition of Lagoon Cell No. 5 north and east of the existing lagoon cells which is located in Bonner gravelly silt loam and Elmira loamy sand. These native soils are suitable for lagoon construction.

B) SURFACE AND GROUND WATER HYDROLOGY

Surface Water

As can be seen on the Vicinity Map in Figure 1 - Google Earth Image of Proposed Project Planning Area. and Figure 2 - Proposed Project Planning Area and Area of Potential Effect., the north end of Spirit Lake abuts against the southeast portion of the City. Spirit Creek outlets from the north end of the lake and flows north through the northeast corner of the City's incorporated area. Spirit Lake is critical resource for recreation, domestic and agricultural water supply, and cold water flora and fauna. The outlet for Spirit Lake is Spirit Creek which, when flowing, runs northerly through the wastewater treatment/disposal site. Spirit Creek is an intermittent stream and does not flow each year. Near the treatment/disposal site, directly to the west is Spring Creek which maintains continuous flow. All construction storm water from the project is to be contained on-site or otherwise mitigated through DEQ's identified Stormwater Best Management Practices. The proposed project is not expected to impact surface water resources in the area.

Ground Water Hydrology

The City of Spirit Lake and the wastewater treatment/disposal site lies within the northeastern portion of the Spokane Valley-Rathdrum Prairie (SVRP) Aquifer, shown in Figure 7 - Spokane Valley-Rathdrum Prairie Aquifer.

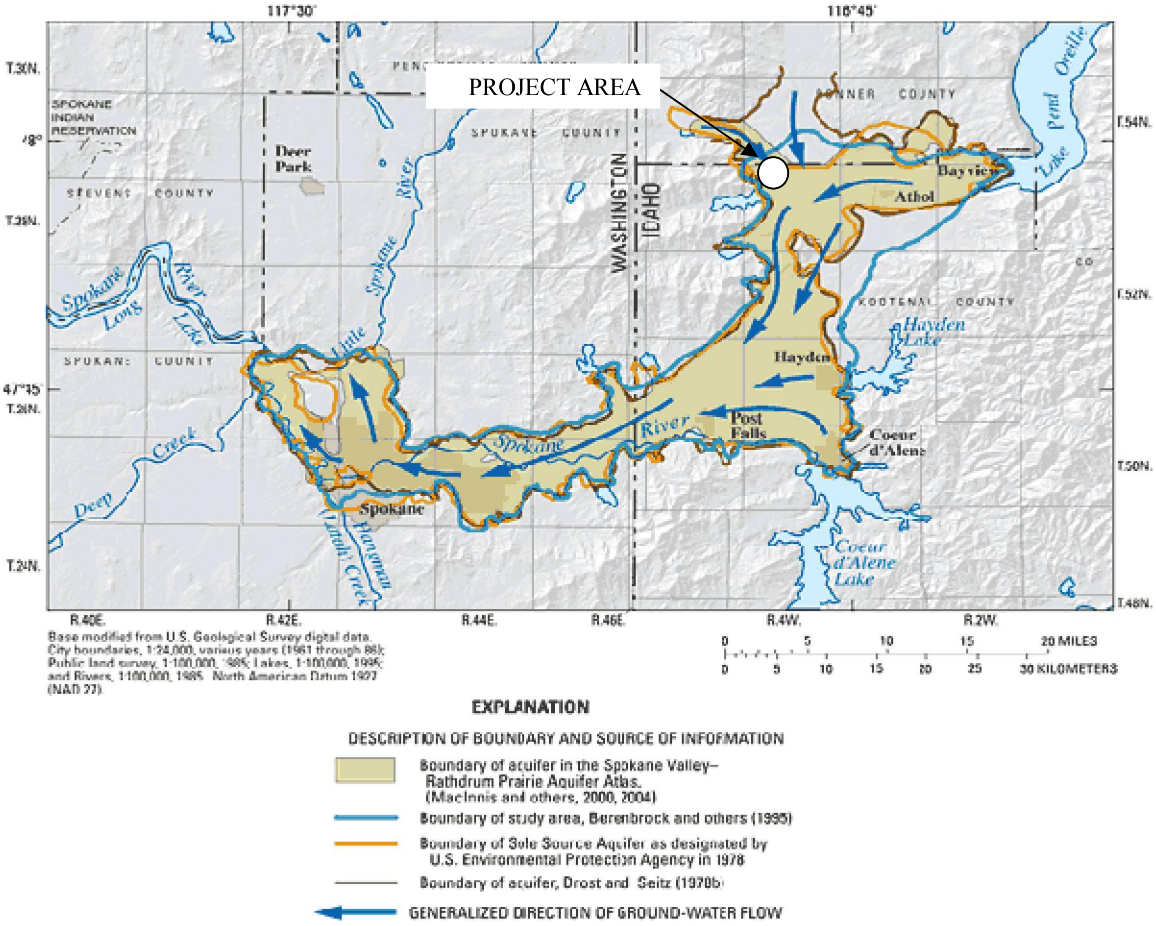

Figure 7 - Spokane Valley-Rathdrum Prairie Aquifer[1]

The SVRP aquifer supplies water to over 500,000 residents in Spokane County, Washington and Kootenai and Bonner Counties, Idaho. The SVRP aquifer was classified a Sole Source Aquifer by the EPA in 1978 due to increasing evidence of the aquifer's vulnerability to water quality degradation. Since 1978 there have been increasing concerns about the effects of increasing urban growth and water demand from the aquifer. The SVRP aquifer is designated by Idaho DEQ as a sensitive resource. This designation provides further projection of the aquifer resource. Through Idaho's sensitive resource designation, the aquifer cannot be degraded unless it is demonstrated that the change is a justifiable result of necessary economic or social development. The aquifer extends from Lake Pend Oreille on its northeastern end to Hangman Creek west of Spokane on its southwestern end. As

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[1] Kahle, Sue C. et al. Compilation of Geologic, Hydrologic, and Ground-Water Flow Modeling Information for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. U.S. Geological Survey Scientific Investigations Report 2005-5227.

shown in Figure 7 - Spokane Valley-Rathdrum Prairie Aquifer, groundwater flow through the aquifer is suspected to be generally from the northeast to the southwest. Recharge of the aquifer is believed to occur through several processes including:

- Infiltration from precipitation
- Infiltration from the Spokane River
- Inflow from tributary basins
- Subsurface seepage and surface overflows from lakes bordering the aquifer
- Return infiltration from irrigation
- Effluent from septic systems

Identified aquifer withdrawal modes include:

- Groundwater well discharge
- Discharge into segments of the Spokane River and the Little Spokane River
- Outflow from the western edge of the aquifer near Long Lake[2]

The City of Spirit Lake relies upon water from the SVRP aquifer as its sole source of drinking water. The City is required to test their drinking water for Nitrates, VOCs, SOCs, Radionuclides, Lead, Copper, and Coliform Bacteria. Recent water quality tests have all indicated that the regulated constituents within the city's groundwater wells are within acceptable levels. Wastewater application and reuse at the wastewater treatment plant is regulated by IDEQ under the Guidance For Reclamation and Reuse of Municipal and Industrial Wastewater. The SVRP aquifer is recognized as a sensitive water source and wastewater reuse is regulated to eliminate degradation of the aquifer water quality.

C) FAUNA, FLORA AND NATURAL COMMUNITIES

Vegetation commonly occurring within the project planning area includes bluebunch wheatgrass, pine reedgrass, huckleberry, sedges, willow, maple, and pine. Native wildlife within the planning area and surrounding vicinity include white-tailed deer, elk, black bear, small mammals, song birds, and forest grouse[3]. According to the United States Fish and Wildlife Service (USFWS), Spirit Lake is not a critical habitat for bull trout and the proposed project is not expected to impact Spirit Lake. The USFWS indicates that there are (2) endangered or threatened species within the project area. According to the USFWS there are threatened Bull Trout (*salve linus confluentus*) and the candidate species North American wolverine (*Gulo gulo luscus*); however the proposed project is not expected to impact either of these species. Due to the overall urban and developed nature of the area at and surrounding the project sites, the project is not expected to significantly impact fauna, flora, or natural communities in the area.

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[2] Hsieh, P.A.. et al. Ground-water flow model for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. U.S. Geological Survey Scientific Investigations Report 2007-5044.

[3] United States Department of Agriculture, Soil Conservation Service, Soil Survey of Kootenai County Area, Idaho (Washington GPO, 1981)

D) HOUSING, INDUSTRIAL AND COMMERCIAL DEVELOPMENT

The City of Spirit Lake has relatively large undeveloped areas within the City limits that could be developed. The following Figure 8 - City of Spirit Lake Development Map. is a map depicting the current development density within the City. Most of the gray area around the center of the City is nearing buildout with few undeveloped lots. This area consists of small businesses and residences that are served by City water and sewer services. The northeast and north-central areas of the City, shown in yellow, include low density development. City water and sewer service exists in these areas. The northwest area of the City, shown in red, includes low density development with no City sewer or water service installed. It is assumed that residences in this area dispose of their wastewater with on-site sewer systems and obtain water from individual wells. The City has since adopted Ordinance #440 prohibiting the installation of on-site sewer systems within the City limits. The east-central, southeast, and west central portions of the City, shown in magenta, have no development and no water or sewer service. The southwest area of the City, just outside of City limits on the west side of Spirit Lake, is shown in blue. This area includes high density development with no City sewer service; however City water service has been installed in this area. These residences are served with on-site sewer systems.

For planning purposes, all wastewater connections are defined in terms of Equivalent Residential Units (ERU). An ERU is the amount of wastewater generated from one average residential connection within the City of Spirit Lake service area. ERU determination differs from city to city based on climate, demographics, socioeconomics, utility rates, and conservation measures. For the City of Spirit Lake, an ERU for wastewater generation was an average of approximately 140 gallons per day over the period 2004 through 2016.

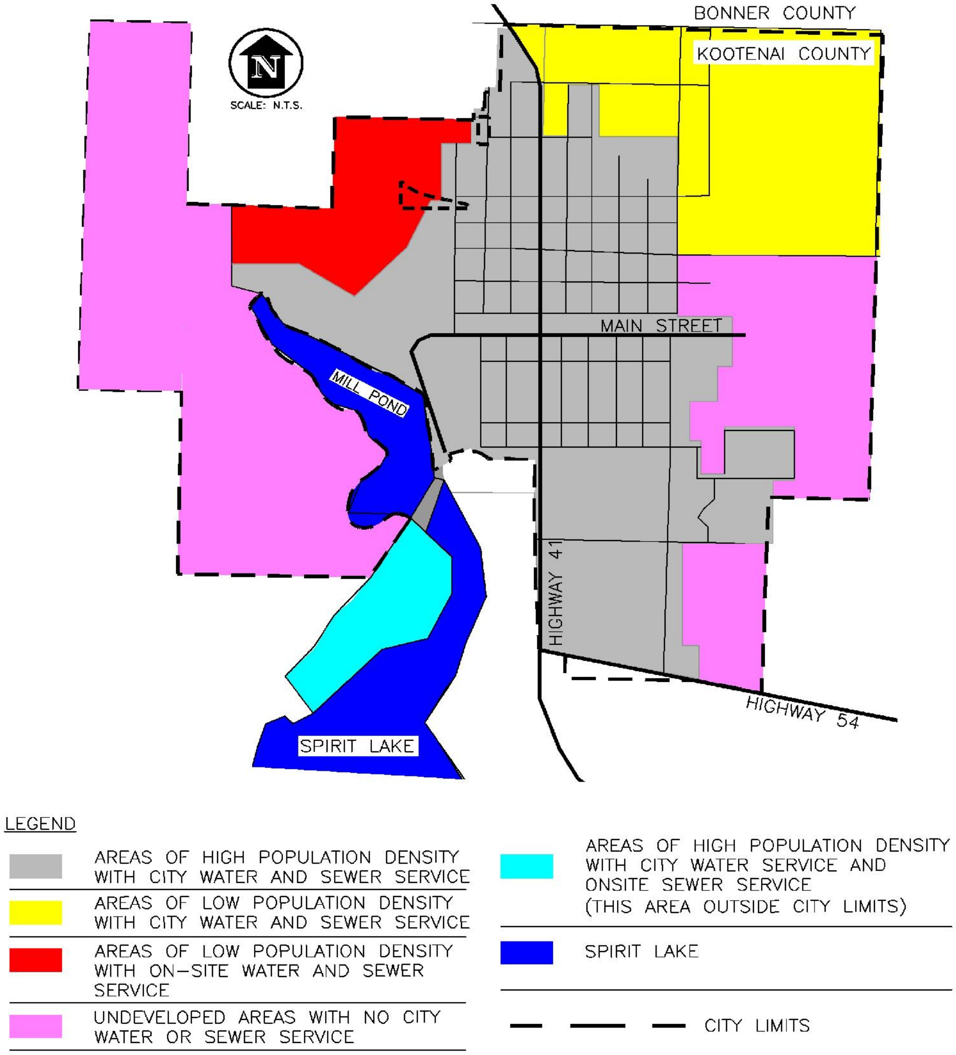


Figure 8 - City of Spirit Lake Development Map.

E) CULTURAL RESOURCES

The Spirit Lake Historic District is listed on the National Register of Historic Places. This Historic District consists of 19 buildings along both sides of Maine Street, most of which were constructed during the period of 1907 to 1910. The proposed project is not expected to impact these historic buildings and no other cultural resources or artifacts are known to exist within the project area. Due to the previously disturbed nature of the project sites there is not expected to be cultural resources at the sites that will be disturbed by the project.

F) UTILITY USAGE

Existing utilities within the project boundary include electrical transmission lines owned and maintained by the Bonneville Power Administration, electrical transmission lines owned and maintained by Avista Utilities and Inland Power and Light, fiber optic lines, phone lines, cable TV lines and natural gas lines located within the project boundary. However construction of this project is not expected to adversely impact any of the existing utilities within the project boundary.

G) FLOODPLAINS/WETLANDS

Copies of the FEMA floodplain maps for the City are shown in Appendix B-3. A floodplain maps for the wastewater treatment plant site is shown below in Figure 9 - FEMA Floodplain map, WWTP Site. The proposed wastewater treatment plant project locations are not located within designated floodplain areas and floodplain areas are not expected to be impacted by the project.

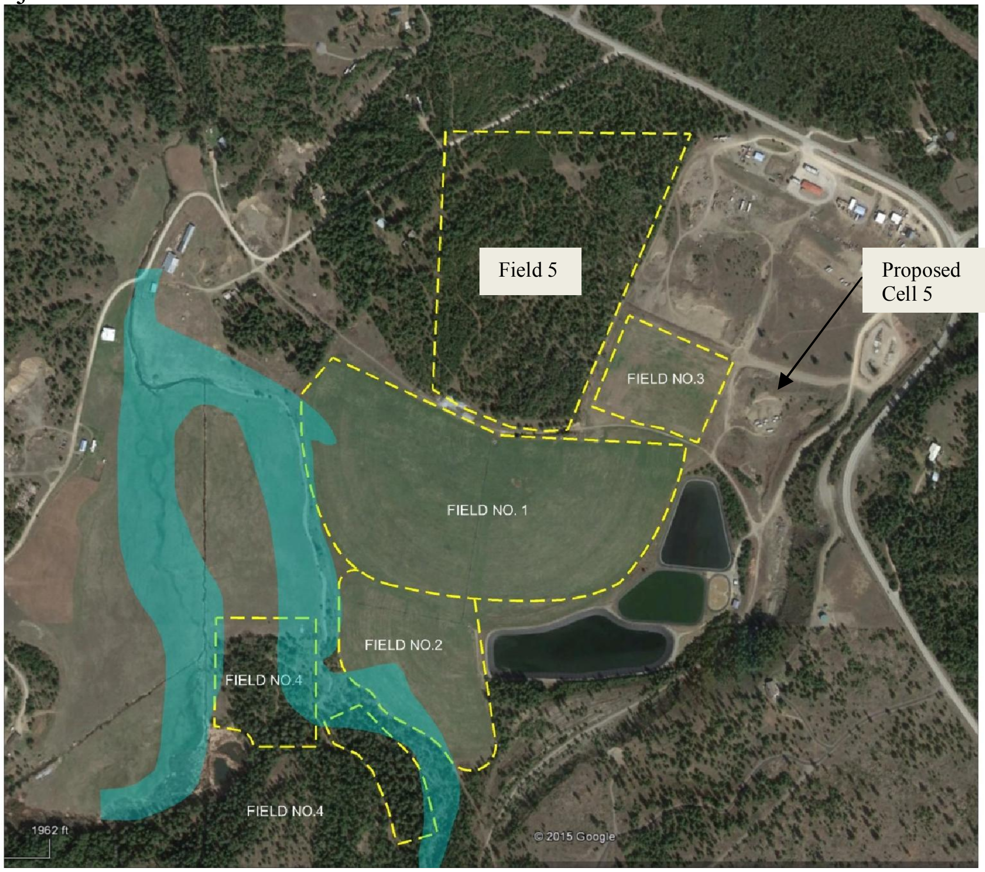


Figure 9 - FEMA Floodplain map, WWTP Site.

H) WILD AND SCENIC RIVERS

Idaho has six designated rivers protected under the wild and scenic river system and two rivers in study. None of the eight wild and scenic rivers are located within the vicinity of the project planning area.

I) PUBLIC HEALTH AND WATER QUALITY CONSIDERATIONS

The proposed wastewater improvement projects are designed to enhance the current treatment plant capacity and provide for a higher level of treatment. The proposed improvements will provide a greater benefit to public health through improved water quality.

J) IMPORTANT FARMLANDS PROTECTION

The current soils within the City Limits of Spirit Lake are not classified as Prime Farmlands by the USDA NRCS. Improvements within the City will not impact prime farmland, prime forest land, or rangeland. The NCRS survey for prime farmland is shown in Figure 10 - NRCS Important Farmland Survey – City Limits., below.

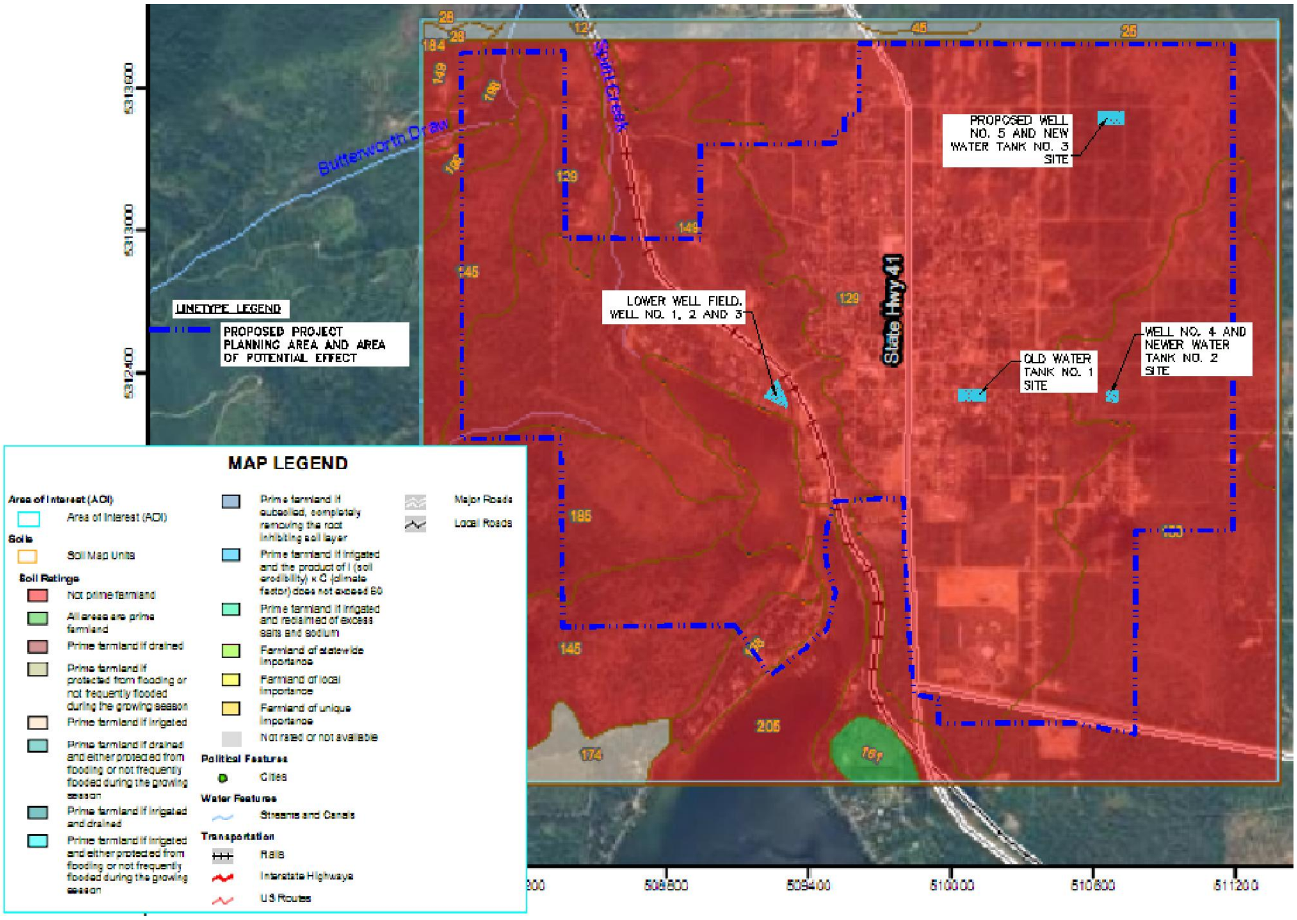


Figure 10 - NRCS Important Farmland Survey – City Limits.

The soils present at the wastewater treatment plant site contain 5 soils listed as prime farmland or farmland of statewide importance. Those areas currently include all areas making up field 1, field 2, field 3, field 4 and field 5. Roughly ½ of the area proposed for lagoon cell No. 5, which equates to roughly 3 acres, is considered prime farmland. This area has been previously disturbed and excavated by the previous property owner. Past use of the proposed Lagoon Cell No. 5 site included a borrow pit with sand excavation and construction of a gun shooting range. The property currently contains excavations and cut banks reaching roughly 15-ft. in height. Now that the City owns this property it will be converted to a lagoon treatment/storage cell and incorporated into the treatment and storage process.

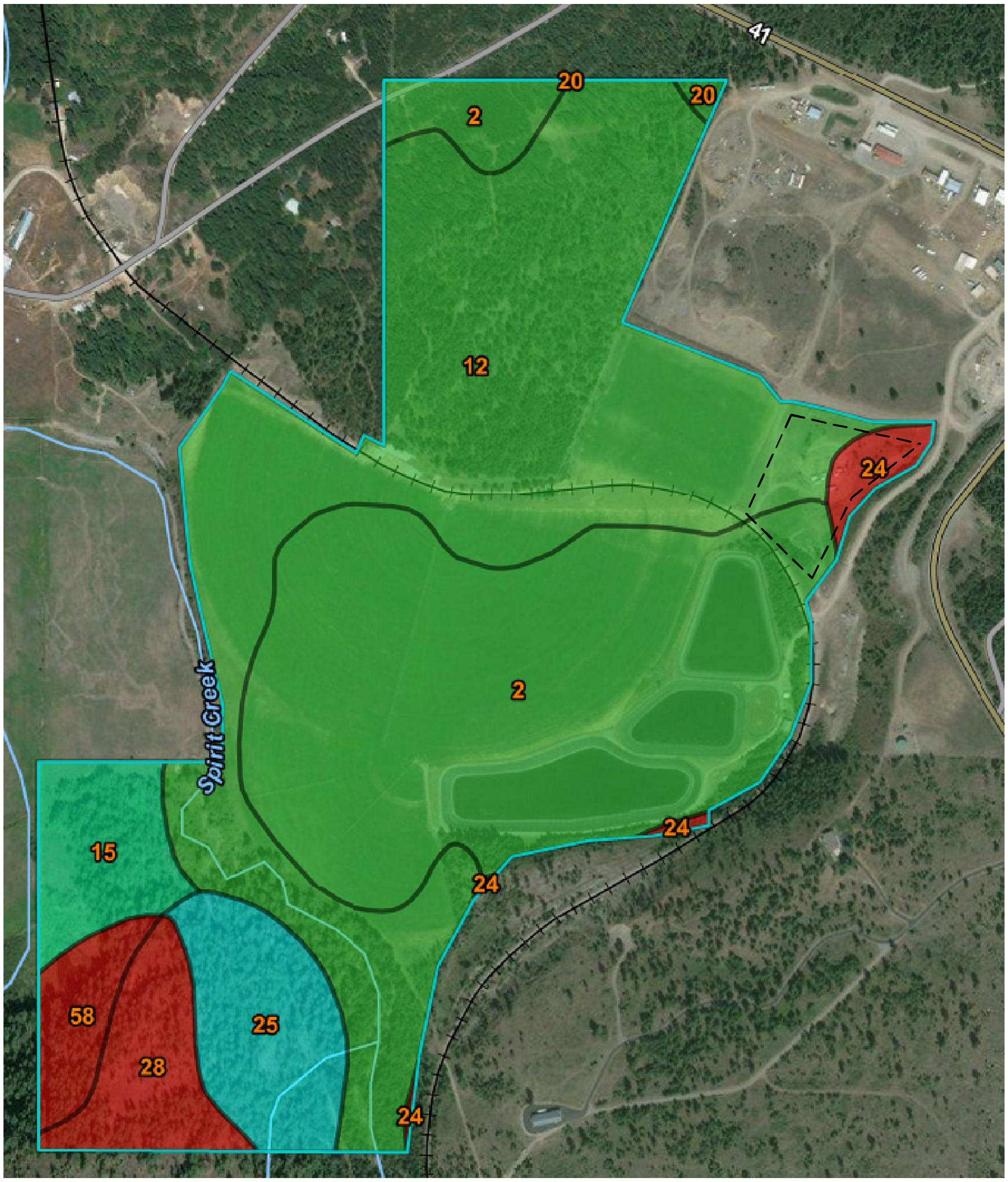


Figure 11 - NRCS Important Farmland Survey - WWTP.

K) PROXIMITY TO A SOLE SOURCE AQUIFER

As indicated in the Groundwater section of this report, the City of Spirit Lake is currently supplied with water from the Spokane Valley-Rathdrum Prairie (SVRP) Aquifer. The wastewater treatment plant and reuse site is located over the SVRP aquifer. Construction of lagoon cell no. 5 will be consistent with DEQ requirements for wastewater storage over the aquifer.

L) LAND USE AND DEVELOPMENT

The area within the wastewater treatment plant boundary has currently been developed and put to use in the wastewater treatment system. Each of the proposed projects will be located at the wastewater treatment plant facility further enhance treatment or provide additional capacity. The wastewater treatment plant site is located in a rural R-5 zoning or in Industrial Zoning areas.

The areas within the existing City Limits will not be impacted by the scheduled wastewater treatment plant improvements. The proposed projects will not provide any adverse impacts to forest land or rangeland.

M) PRECIPITATION, TEMPERATURE AND PREVAILING WINDS

The Western Regional Climate Center lists the following climate information for the project area, for the Bayview Station, which is the Station nearest to Spirit Lake:

- Average Maximum Temperature: 80.0 °F (July)
- Average Minimum Temperature: 21.3 °F (Jan)
- Average Annual Total Precipitation: 24.21 inches
- Average Total Snowfall: 37.1 inches

The prevailing winds for the proposed project planning area come from the northeast. The WRCC climate data can be found in Appendix B-5.

N) AIR QUALITY AND NOISE

The proposed project construction does not fall within the category of a major source emission rate activity. Air and dust emissions during construction activities will comply with all federal and state standards and regulations. Noise due to construction will be allowed only during daylight hours unless special permission is obtained from the City by the construction contractors.

O) ENERGY PRODUCTION AND CONSUMPTION

The proposed projects will require the installation of high efficiency lagoon surface aerators, which is expected to marginally increase power consumption within the City of Spirit Lake wastewater treatment plant site. The proposed project will provide the most efficient use of power to operate the aerators at current and projected development. The wastewater system will be managed by the City of Spirit Lake operational personnel to provide adequate treatment while minimizing power consumption.

3. Socioeconomic Project and Population Statistics

A) POPULATION PROJECTION

To better understand realized population growth within the City of Spirit Lake, the following Table 1 presents a summary of the populations listed for the City of Spirit Lake, and Kootenai County as presented by the U.S. Census Bureau.

Table 1 – Population per US Census Bureau

	1990	2000	2008	2010	2014	2016	Growth Rate*
Spirit Lake, ID	790	1,376	1,486	1,945	2,001	2,167	3.96%
Kootenai County, ID	69,795	108,685	137,475	138,494	147,326	154,365	3.10%

*The calculated growth rate is based on U.S. Census data for the listed areas for the years of 1990 to 2016.

From the above table, the average population growth within the City of Spirit Lake over the last 26 years has been approximately 4%. The proposed wastewater system improvements will eliminate several development constraints that are currently restricting growth. Those limitations include issues associated with lagoon storage and wastewater treatment capacity. Planning for future growth within the project area will be based on wastewater system historical data, which is comparable to a growth rate of 3.96% as indicated by the U.S. Census data. Considering the 2016 City of Spirit Lake population of 2,167 people, and a growth rate of 4.0%, the projected population to be serviced in 20 years is 4,938 people and 10,820 people in 40 years.

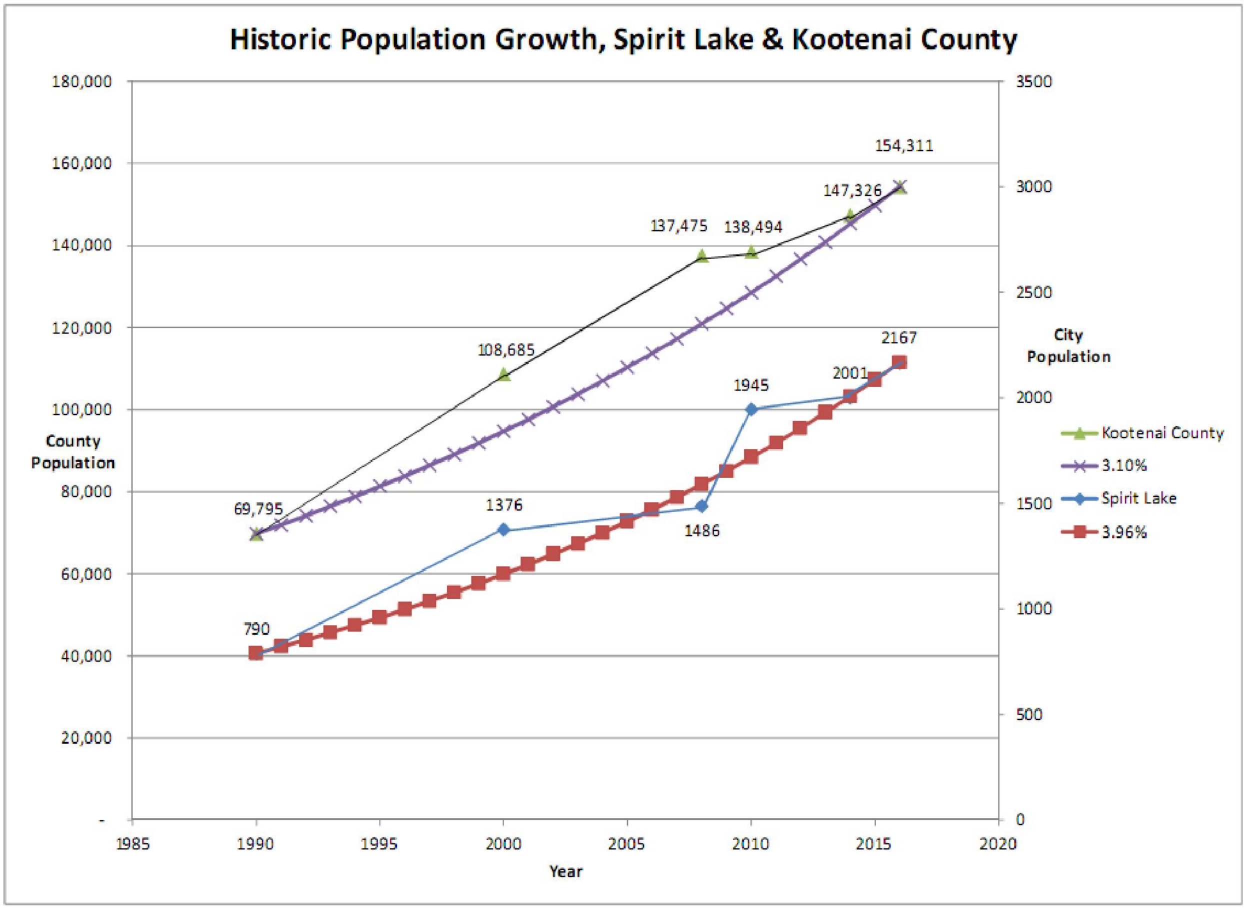


Figure 12 - Spirit Lake Population Trend.

B) SOCIOECONOMIC IMPACT

According to the U.S. Census Bureau, the estimated median household income in 2010 for Bonner County was $41,943. The median household income in Spirit Lake in 2000 was $28,854. The estimated median household income in Kootenai County in 2010 was $46,336. The median resident age is 35.9 years and the population is approximately 95% Caucasian. U.S. Census data for City of Spirit Lake and Kootenai County can be found in Appendix B-6.

The proposed project will indirectly facilitate light industrial and commercial business establishment and the construction of new homes within multiple income brackets. For these reasons, the proposed project is anticipated to provide an overall improvement of the socio-economic status in the City of Spirit Lake.

4. Agency Consultation/Community Engagement

A) AGENCY CONSULTATION

The environmental evaluation process will include the following tasks:

- Identification of possible impacts to environmental sensitive resources. Impacts to environmentally sensitive resources would primarily be associated with the construction of a new lagoon cell at the City's wastewater treatment facility. No wetlands are known to existing within any of the proposed construction sites.
- Consultation with resource agencies, which will include the Corps of Engineers, Idaho Department of Fish and Game, U.S. Fish and Wildlife, Idaho DEQ, Idaho State Historical Preservation Officer, and the Coeur d'Alene Indian Tribe. Other agencies may be contacted as necessary.
- Preparation of the final Environmental Information Document, which will include incorporation of mitigating measures during the design and construction tasks of the project.

B) COMMUNITY ENGAGEMENT

The City of Spirit Lake will be applying for loan money to complete the Lagoon Cell No. 5 construction project. Consequently, they will be putting forth a bond election to the people in May of 2018 to seek approval for the loan. As part of the bond election process the City will be discussing the projects at their regular City Council meetings and conducting public information workshops to provide education and an understanding on the need for the projects. The public information workshops will include discussions about funding, rate impacts, capacity and treatment improvements and overall input on the project priorities and direction forward for the wastewater system.

C. Existing Facilities

1. *Location Map*

The City wastewater collection system consists of gravity collection pipelines and manholes serving the majority of the City. There are four wastewater lift stations serving segmented areas of town. Two of these lift stations serve the Spirit Shores development adjacent to the Mill Pond, one lift station serves the Blackwell area and Schools in the south area of town, and one lift station serves the R-Ranch subdivision in the northeast portion of the City. A map of the overall collection system is shown in Figure 13 - Overall Sewer Collection System.

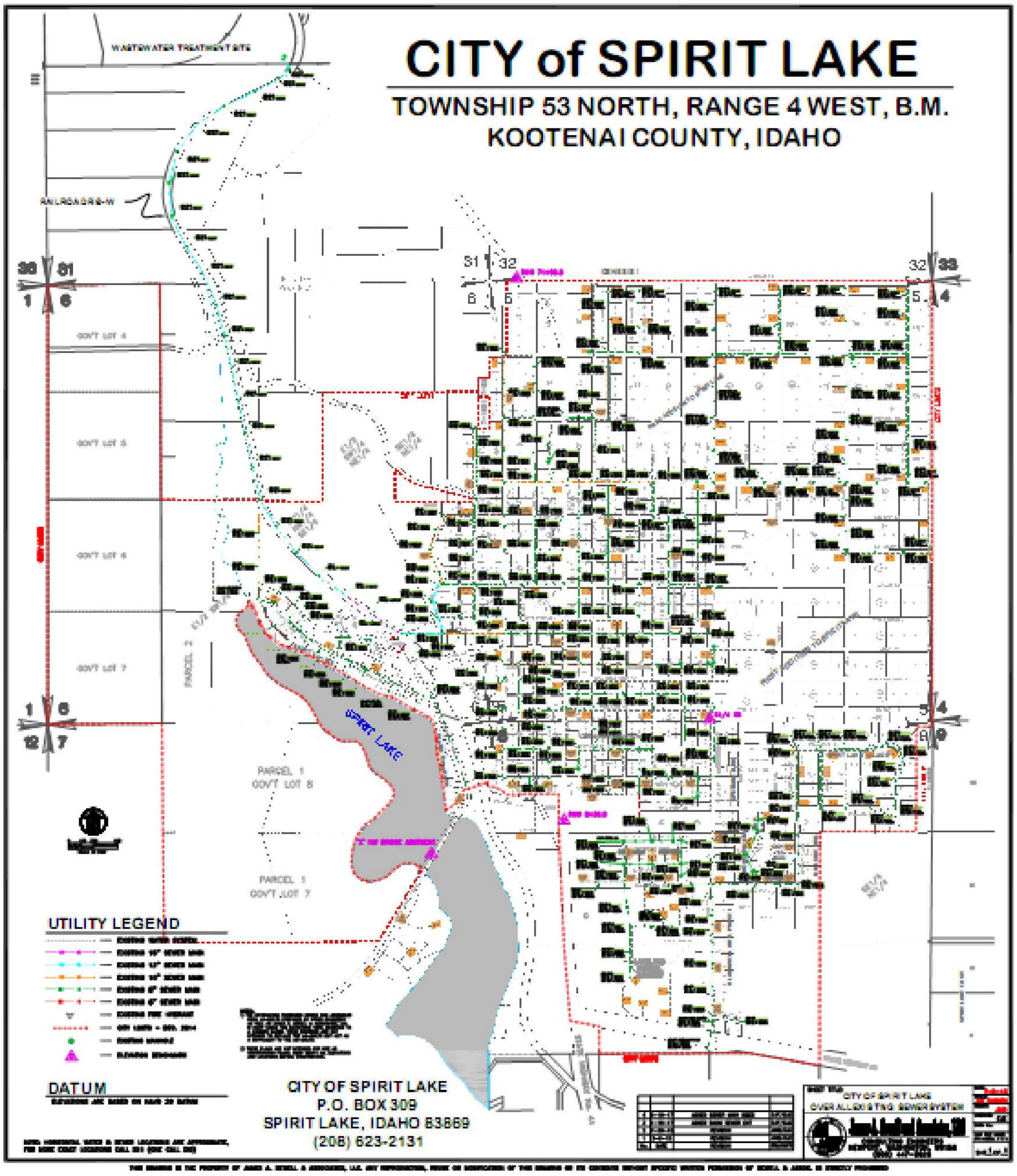


Figure 13 - Overall Sewer Collection System.

The wastewater treatment/disposal facility is located approximately 1 mile north of the City. The sewer mainline transporting wastewater to the wastewater treatment/disposal facility was installed along the abandoned railroad grade between town and the wastewater treatment/disposal facility. The wastewater treatment/disposal facility is constructed with a headworks screening facility, four existing lagoon storage/treatment cells, irrigation pumping stations and land application/reuse areas. A map showing the wastewater treatment/disposal facility components and neighboring wells is shown in Figure 14 - Overall Wastewater Treatment/Disposal Facility.

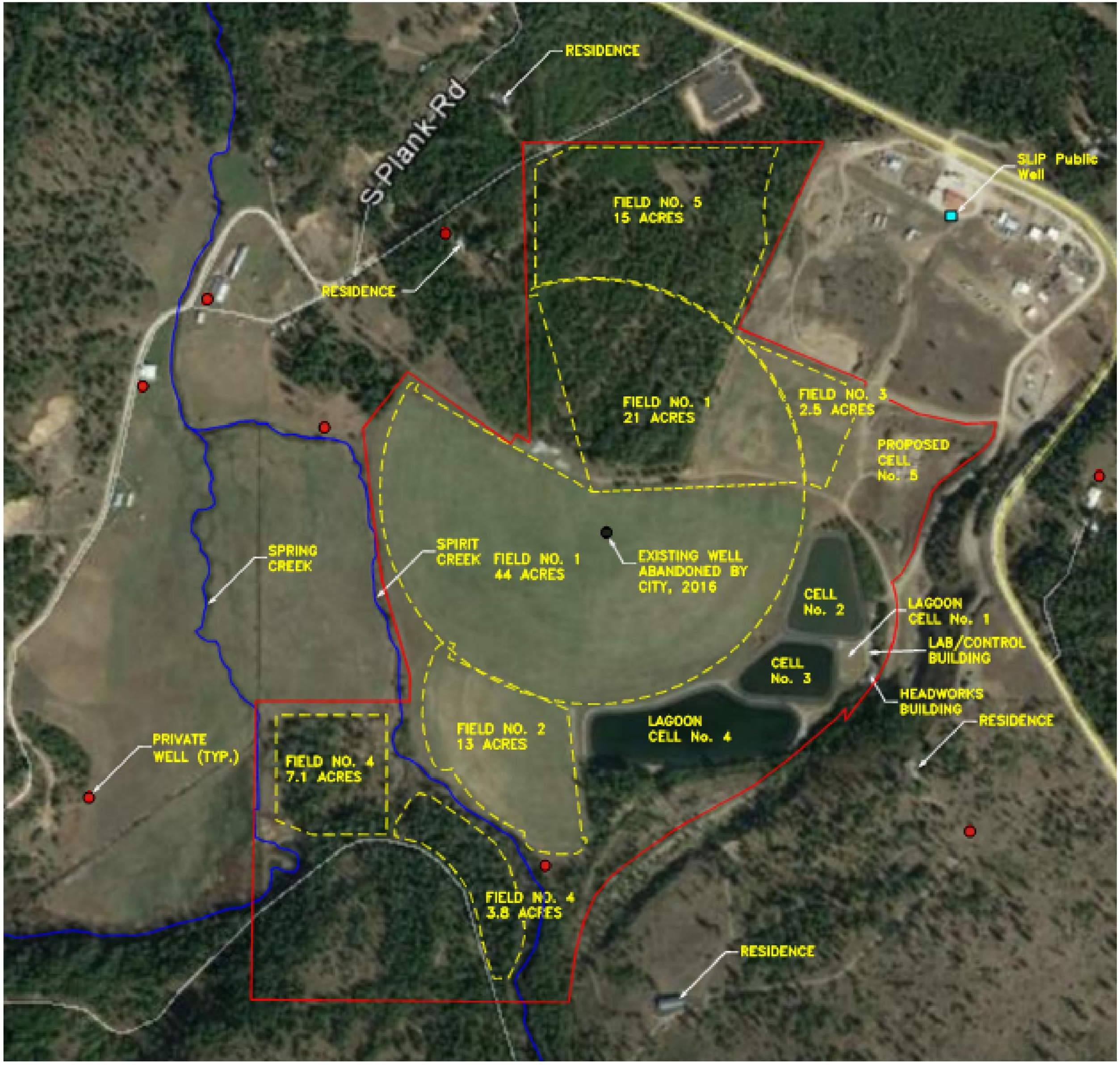


Figure 14 - Overall Wastewater Treatment/Disposal Facility.

● Residential Well
■ Public Well
━ City of Spirit Lake Property Boundary
╍ Irrigation Area Designation

The wastewater treatment/disposal facility is a land based system utilizing approximately 78 acres of cropland and 29 acres of forest irrigation area. Wastewater is treated through screening, aeration, storage and disinfection prior to irrigation. The screening equipment is located in the headworks building and serves to remove the trash and inorganic debris that enters the plant. Lagoon Cells 1 and 3 current have aeration capacity for biological treatment. Lagoon Cells 2, 3 and 4 are utilized for winter storage until irrigation can begin during the summer growing season. All treated wastewater is disinfected with chlorine to deactivate and kill pathogens or disease causing organisms prior to irrigation. The City utilizes five different irrigation areas to apply treated wastewater for beneficial use. A schematic of the plant hydraulic flow is shown in Figure 15 - Overall Wastewater Treatment Schematic.

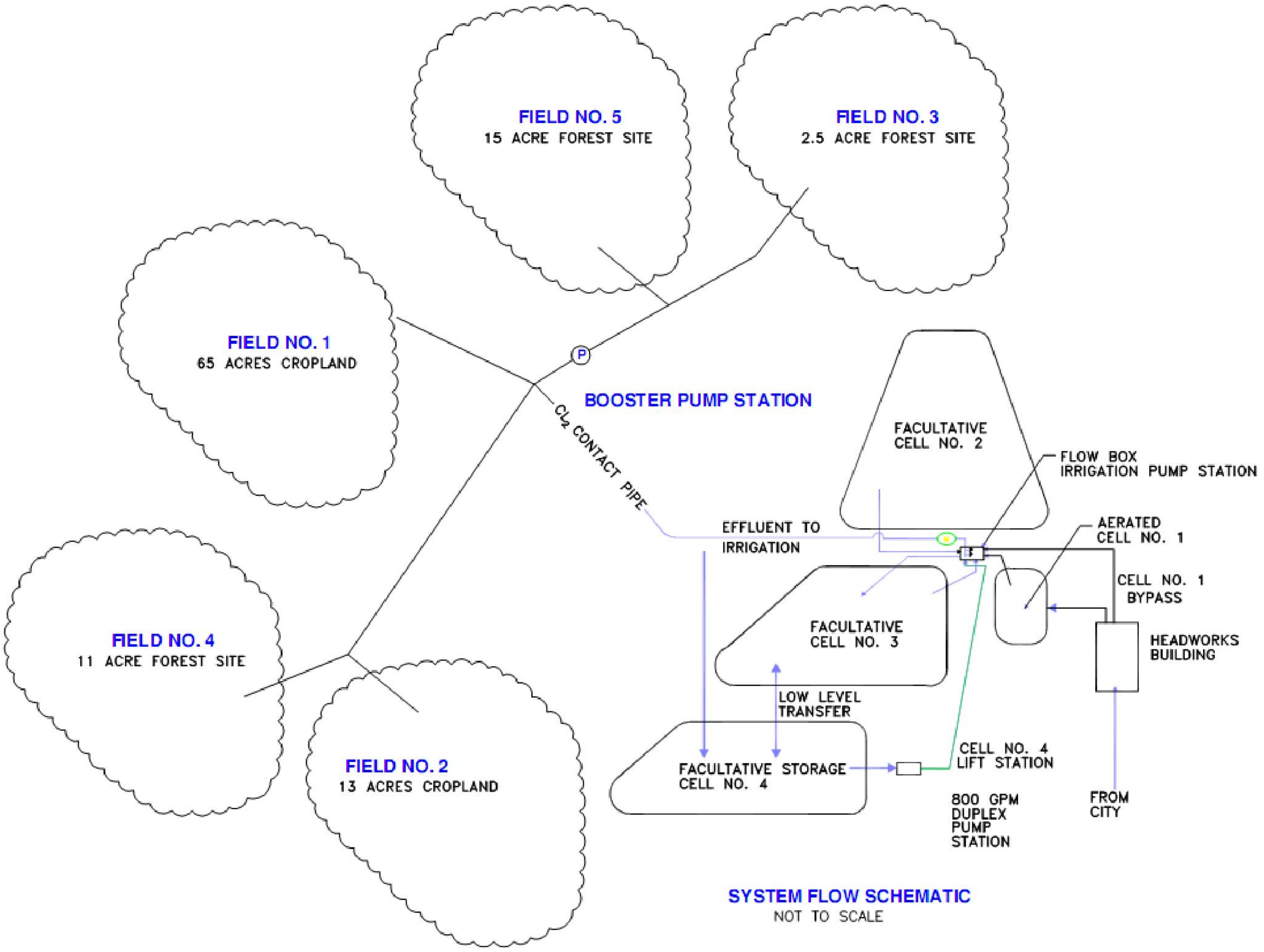


Figure 15 - Overall Wastewater Treatment Schematic.

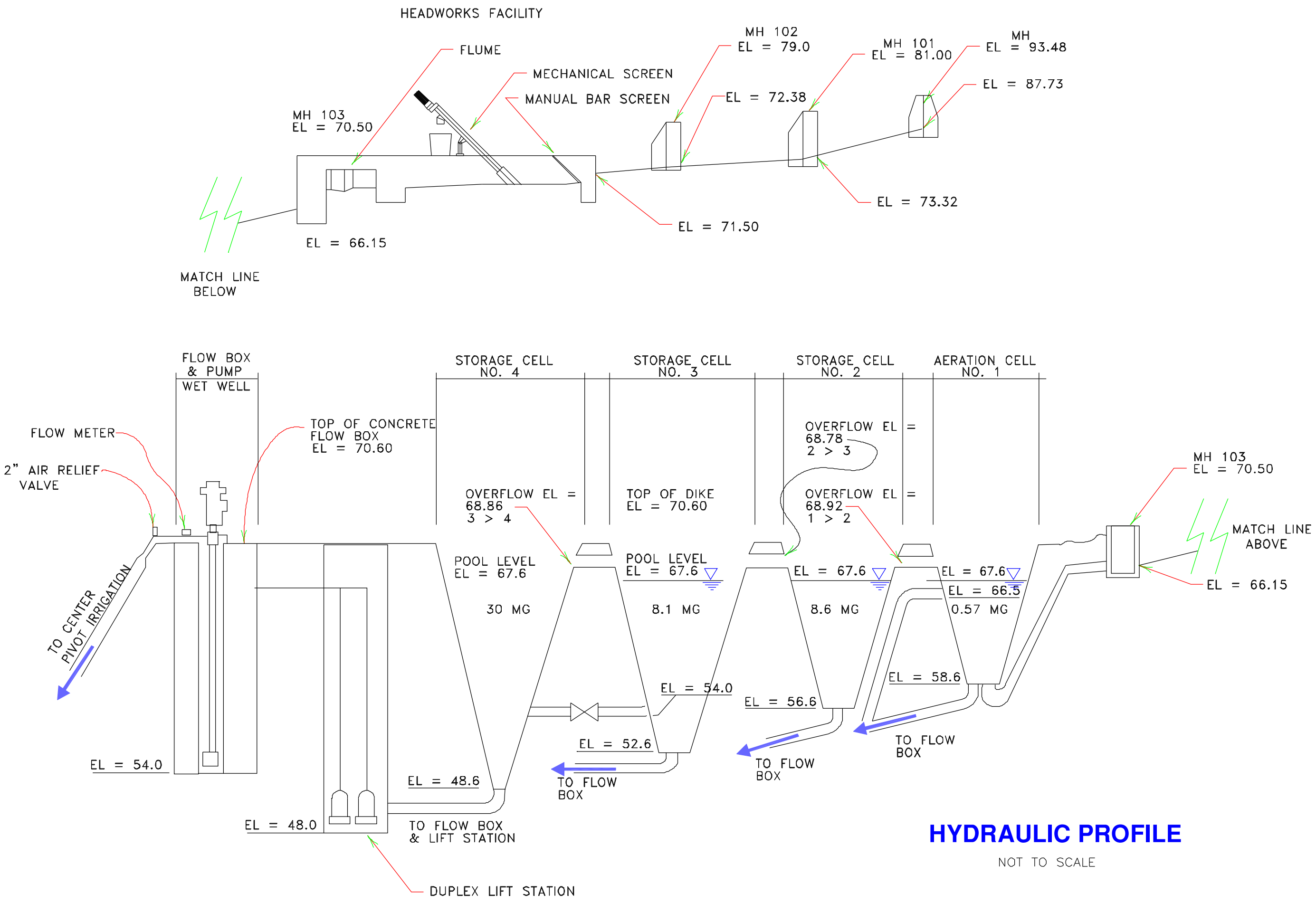


Figure 16 - Overall Wastewater Treatment Hydraulic Profile.

2. Site Management History

The existing plant was originally constructed in 1977 with a series of upgrades beginning in 1983. The original plant consisted of three lagoons and land application to alfalfa and grass crops in Field No. 1 and a portion of the existing Field No. 2. Alfalfa has been grown and harvested by the City in their Land Application Areas since 2002. Fertilizer has not been applied to any of the land application fields to date. Important events in the history and management of the plant and land application areas are summarized in Table 2 - Spirit Lake Wastewater Treatment Plant Site Management History Timeline.

Table 2 - Spirit Lake Wastewater Treatment Plant Site Management History Timeline

Date	Event
1977	Existing plant constructed including aerated Cell No. 1, stabilization and storage Cell Nos. 2 and 3, Operations Building, chlorine system, and center pivot land application to Field No. 1.
1983	Plant upgrade, including lagoon excavation & liner installation, and piping and control system improvements.
1993	Cell No. 4 constructed.
2002-2003	Irrigation upgrade including the installation of the new Center Pivot No. 1 and Center Pivot No. 2, expansion of Field 2, the addition of Field 3 with wheel line irrigation, and improvements to the pumping system and piping network. Seeded alfalfa began to be grown and harvested in all three fields.
2003-2004	Wastewater treatment upgrades included the expansion of Lagoon No. 4 and construction of the headworks building and screening system.
2003-2004	Chlorine contact pipe was expanded with the addition of a 36-inch ductile iron pipe to the existing 21-inch AC pipe to increase chlorine contact time.
2006-2007	Field 4 was added with solid set lateral irrigation to forest land.
2007	Crop plan submitted and approved by DEQ. Plan calls for scheduled rotation of alfalfa and oats in all three fields. Implementation of oat crop is pending agreement by farmer.
2013	Plug valves within the flow box were replaced to allow for lagoon leak testing.
2014	Seepage rate testing of the lagoons in April - May, completed spring 2015.
2016	Replace irrigation pump check valves and discharge manifold piping.
2016	Purchase Bice Property, clear and grade southern ½ as an expansion center Pivot No. 1 operation and therefore expand Field No. 1 to 65 acres from 44 acres.
2017	Install aeration in Lagoon Cell No. 3, Add 40 hp of aeration capacity.
2017	Replace lagoon cell No. 1 bypass piping
2017	Construction Perimeter Fence around Field No. 5
2017	Replace Irrigation Pumps at Flow Box, Replace with 400 gpm @ 200’ TDH
2017	Extend Irrigation Manifold to east side of Field 3, Install Solid Set Sprinklers in Field 3 for future forest irrigation
2017	Extend Irrigation Manifold to Field 5, Install Solid Set Sprinklers in Field 5 for forest irrigation
2017	Purchase Griffin Property for future construction of lagoon cell no. 5.

2017	Relocate Spirit Lake Industrial Park Water Line out of Field 1 to Paisley Road
2018	Install Irrigation Booster Pump Station to serve fields 3 and 5 along with update overall system automation capability and record keeping.

Historically the plant operation has been very good. The effluent applied to the land application site is tested weekly for total coliform count. The City's current permit provides a limit to the total coliform count of less than 23 organisms per 100 ml in the irrigated effluent. Generally the irrigation season begins in May and ends in September and has averaged between 19 and 22 weeks in length. The following table summarizes the effluent total coliform testing, noting the number of violations between 2007 through 2017.

Table 3 - Wastewater Effluent Total Coliform Testing

Year	Total Number of Coliform Tests	Number of Total Coliform Test - Violations
2017	20	2
2016	22	0
2015	19	0
2014	22	5
2013	21	3
2012	19	5
2011	20	6
2010	20	4
2009	20	4
2008	19	2
2007	21	7

3. *Condition of Existing Facilities*

Major Equipment Size and Design Capacities. Details of the major equipment are included in Table 4.

Table 4 - Existing Equipment Properties and Capacity

Process or Design Criteria	Value
Influent Flow Meter	
Type	3” Parshall Flume w/Ultrasonic Level Sensor & Chart Recorder
Flume Model	Tracom: 3” Nested Inside 6” Parshall Flume
Level Sensor Model	Eurotherm Chessel 7ML1100
Chart Recorder Model	Clear-View 394
Quantity	1
Capacity	0 – 1.0 MGD
Headworks Channel Automated Screen	
Type	Perforated Plate Microstrainer (Fine Screen)
Model	Lakeside Equipment Corporation 16MS-0.25-100
Screening Size	1/8 inch
Flow Capacity	480 gpm
Motor	2 hp, 480V, 3Ø
Quantity	1
Control System	Ultrasonic Level Sensor, PLC, Timer

Process or Design Criteria	Value
Alarms	Motor Overload, Drive Power Overload, High Level Alarm
Lagoon Aerators	
Type	Aspirating Floating Surface Aerators
Quantity	6 total, 4ea-10hp, 2ea-5hp
Low Speed Capacity	Net Oxygen Transfer of Each at Low Speed = 1.0 lb/hp/hr
Control System	Manual On / Off
Irrigation Pumps	
Type	Vertical Shaft
Quantity	2
Capacity	400 gpm at 200 ft head each
Control System	Pressure Transducer in Discharge Line
Chlorine System	
Type	Gas Chlorination
Quantity	2 Chlorine Cylinders, 1 Rotometer
Rotometer Capacity	150 lb., model S10K
Cylinder Regulator	Evoqua, W3T97930
Manufacturer	Wallace and Tiernan
Center Pivot Irrigation System	
Pivot 1 – 986' plus 50-ft end gun	(4) 179' spans, (1) 135' span, (1) 113' span, 22' overhang
Manufacturer	Lindsay - Zimmatic
Capacity	500 gpm without end gun
Serial #	L78465 07-08-2
Max End Tower Speed	10.2 fpm
Tire Size	14.9"x24"
Gearing	43 rpm
Drive Motors	480V, 60 Hz, 3Ø
Pivot 2 – 650' plus 100-ft end gun	(2) 179' spans, (1) 113' span, 44' overhang
Manufacturer	Lindsay – Zimmatic
Capacity	250 gpm without end gun
Serial #	
Max End Tower Speed	10.2 fpm
Tire Size	14.9" x 24"
Gearing	43 rpm
Drive Motors	480V, 60 Hz, 3Ø
Control System	Field Boss Control System, Manual On, Auto Off
Lagoon Cell 4 Lift Station	
Type	Submersible Sewage Pumps
Model	Fairbanks Morse #5431 replaced with Barmesa
Quantity	2
Capacity	400 gpm @ 41 ft TDH
Motor	1735 rpm, 460V, 10 HP
Control System	Manual

A) HEADWORKS FACILITY

Raw sewage from the City enters the Headworks Building through a 12-inch ductile iron gravity main. A flow diagram for the Headworks Building is shown in Figure 17 - Headworks Flow Diagram.

Inside the Headworks building, the sewage outlets to a small rock trap chamber. Flow passes through the rock trap into a 48 inch deep concrete channel with a coarse bar screen that is cleaned manually by the operator. Downstream of the coarse bar screen a mechanical screen removes a large fraction of the inorganic solid waste that passes through the bar screen. The mechanical screen washes the waste and drops it into a trash receptacle that is manually emptied and disposed of at an off-site landfill.

A concrete bypass channel allows for the diversion of the wastewater stream around the primary flow channel when necessary. The bypass channel contains a fine bar screen which is cleaned manually by the operator when it is in use.

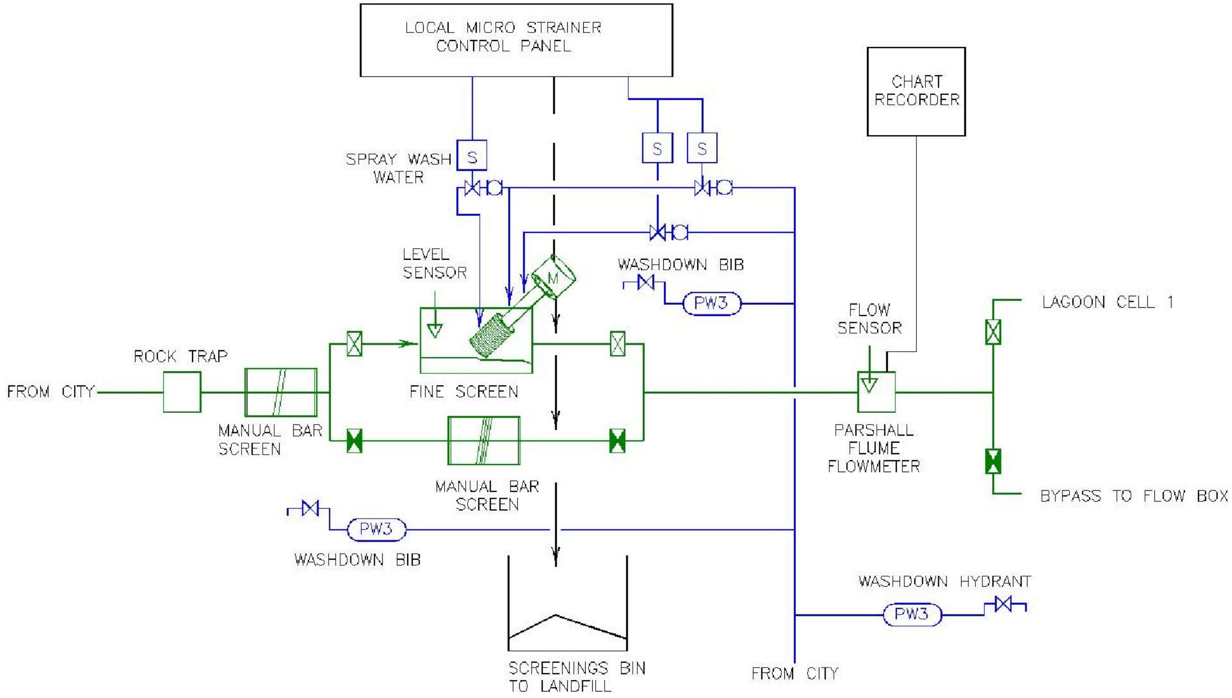


Figure 17 - Headworks Flow Diagram

Both the primary and the bypass flow channels outlet to a common channel with a Parshall flume meter that records the influent flow. Wastewater flows out of the flume into an outlet box which contains two gates that control whether wastewater goes into the Lagoon Cell No. 1 or is bypassed to the concrete flow box. The capacity of the headworks facility is limited by the in-channel fine screen. The current capacity is roughly 0.69 million gallons per day (MGD). A second fine screen could be added in the future in the bypass channel to increase the headworks screening capacity. The current flow meter is a 3-inch flume nested inside a 6-inch flume. The 3-inch flume has a capacity of 1 MGD. When expansion in excess of 1 MGD is needed the 3-inch flume will be removed. The overall condition of the headworks facility is fair. The interior of the screening room has suffered from high humidity and poor ventilation. The overhead door and exhaust fans are significantly corroded. The paint is peeling off the CMU walls. A screening room heater and continuously ventilation system would mitigate the high humidity and corrosion issues currently present in the headworks screening room.

B) LAGOON AERATION, CELLS 1 AND 3

Lagoon Cell No. 1 is an aerated cell, with two 5 horsepower floating aerators. Cell No. 1 operates at a constant depth of approximately 9 feet with the water level controlled by an overflow weir in the flow box. An outlet in Cell No. 1 allows water to be drawn from the top four feet. Aerators were recently installed in Lagoon Cell No. 3 in 2017. The Lagoon Cell No. 3 aeration system is activated when the liquid depth in the lagoon is above 7-feet. Lagoon Cell No. 3 is also utilized as a storage cell so the water level fluctuates between 3 feet near the end of the irrigation season in October and 15 feet. Lagoon Cell No. 3 contain four 10 horsepower floating aerators. The base of lagoon cell 3 contains a sand layer covering the existing PVC liner. The aerators in cell No. 3 are turned on after there is sufficient depth in lagoon cell No. 3 to prevent erosion of the sand layer in the base. The oxygen demand based current plant influent is calculated as follows:

Average Daily Flow = 150,000 gpd.
Estimate Influent BOD$_5$ = 220 mg/l
Estimated Total Nitrogen = 40 mg/l
Oxygen Required for BOD$_5$ oxidation = 1.1
Oxygen Required for N oxidation = 4.6
Extended aeration peak factor = 1.5

Organic Demand = 0.150mgd x 220 mg/l x 8.34 x 1.1 x 1.5 = 454 lbs O$_2$
Nitrogen Demand = 0.150 mgd x 40 mg/l x 8.34 x 4.6 x 1.5 = 345 lbs O$_2$
Total Current Oxygen Demand = 799 lbs / day

The oxygen provided with the 2017 addition to the aeration system is calculated as follows:

Lagoon Cell No. 1 Aerators, 2ea @ 5HP = 10 HP
Lagoon Cell No. 4 Aerators, 4ea @ 10HP = 40 HP
Total 50 HP

Oxygen Transfer Rate = 1 pound O$_2$/HP/HR
Current Aeration System Capacity
= 50 HP x 1 LB./HR/HP x 24 HR/Day
= 1,200 LBS / Day

Prior to the Lagoon Cell No. 3 aeration project the system was providing a total of 240 lbs. of oxygen per day. The estimated electrical cost to operate the Lagoon Cell No. 1 aerators is as follows:

10 hp *(0.746 KW/HP)*(24 HRS/DAY)*($0.065 / KWH) = $ 11.64 / Day

Continuous operation of the Cell No. 3 aerators will increase the electrical usage as follows:

40 hp *(0.746 KW/HP)*(24 HRS/DAY)*($0.065 / KWH) = $ 46.55 / Day

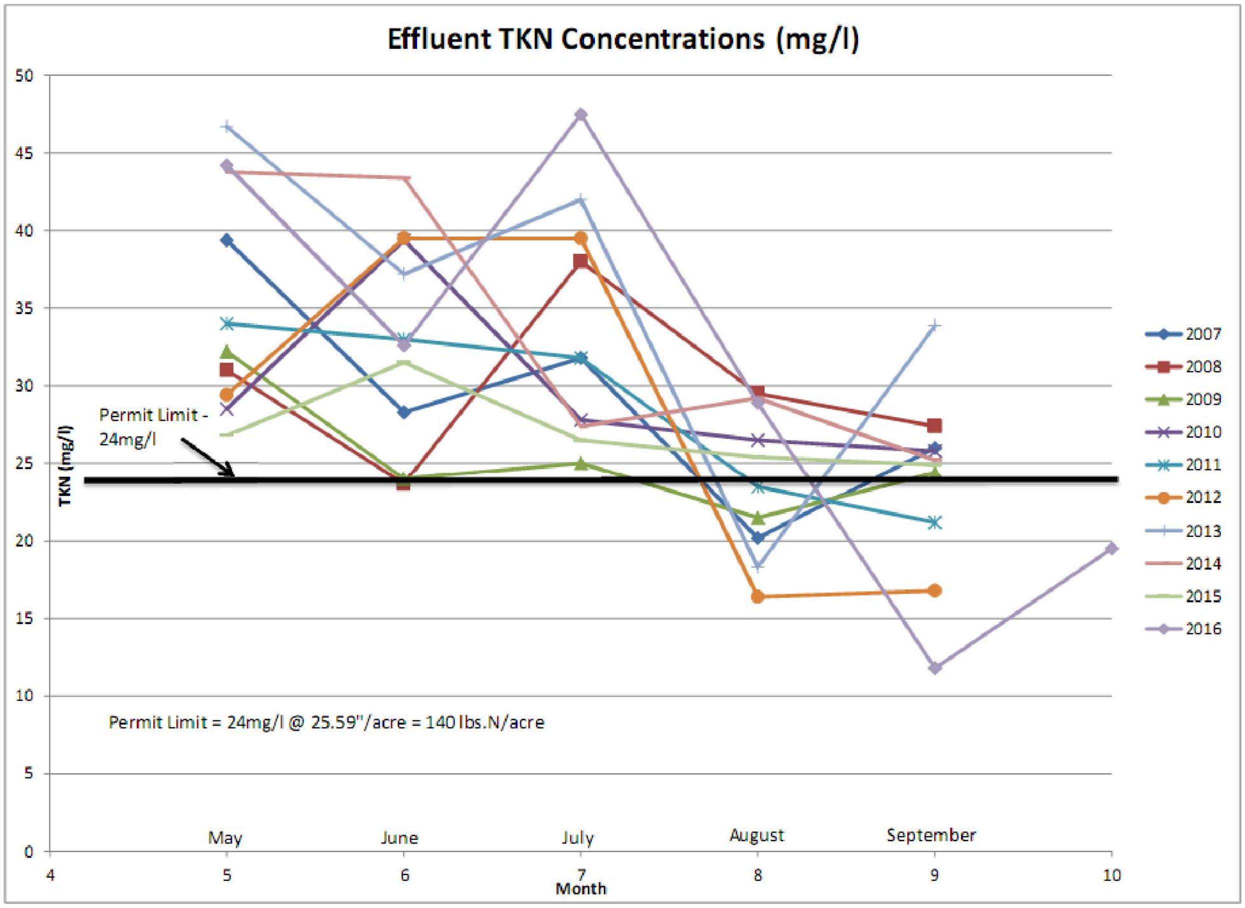


Figure 18 – Effluent Nitrogen Concentrations.

Figure 18 above shows the effluent TKN concentrations in mg/l. These tests are conducted each month that irrigation is occurring. The forest sites have a maximum nitrogen application rate of 140 pounds per acre applied for the growing season. The wastewater effluent Nitrogen concentration is generally well above the calculated permit limit of 24 mg/l which results in application of Nitrogen in excess of the permit limit for the forest sites. This is telling of inadequate biological treatment. The above graph also shows that the most recent years of 2013, 2016, and 2014 the May nitrogen concentration was the highest and the prior years of 2008 – 2012 the May nitrogen concentration started out roughly 10 points lower. This is suggestive that the recently increased flows and therefore increased organic demand received at the plant outpacing the treatment system capability.

The results of the installation of aeration in Lagoon Cell No. 3 will not be realized for some time. The Lagoon Cell No. 3 aerators were started this summer but then shut down because they were agitating the sludge layer in the bottom of Lagoon Cell no. 3. The plant effluent is drawn from the base of Lagoon Cell No. 3 prior to irrigation and the additional sludge in the effluent created problems with disinfection prior to irrigation. The Lagoon Cell No. 3 aerators will be restarted this upcoming December when the water lever in cell No. 3 has reached 7-feet. The result of this operational hurdle is that for roughly ½ of the year the lagoon cell No. 3 aerator were not in operation. It is anticipated that operation next year will be similar, and if that is the case the adjusted oxygen provided by the aeration system is effectively reduced from 1,200 lbs./day to 720 lbs./day. Two potential solutions for this problem are currently planned. The first is to install an irrigation intake in Lagoon Cell No. 3 to allow withdrawal of effluent from the top or any point between the surface and the floor of the lagoon cell. The operator would have the ability to set the irrigation intake level to capture the cleanest wastewater for irrigation. Currently the irrigation intake from Lagoon Cell No. 3 is directly off the bottom of the lagoon. The second option is to install aeration in Lagoon Cell No. 4. In this option the aerators in Lagoon Cell No. 4 could be operated when the aerators in Cell No. 3 are turned off for irrigation.

C) LAGOON STORAGE

Lagoon Cell Nos. 2 and 4 are facultative cells that are used for further treatment and storage. Cell No. 4 has been constructed to allow the installation of floating aerators in the future and the City intends on installing aerators in Cell No. 4 as one of its plant improvement projects. Water levels in the storage cells fluctuate throughout the year with the highest levels obtained at the end of the winter storage period and the lowest levels in the fall at the end of the irrigation season.

Wastewater can be directed from the flow box to Lagoon Cells 2, 3 or pumped to Cell 4 for biological treatment and winter storage or pumped directly to the land application areas. Normal operation directs wastewater from Lagoon Cell No. 1 through the flow box to Lagoon Cell No. 2 and then back through the flow box and out to Lagoon Cell No. 3 and then overflow from Lagoon Cell No. 3 into Lagoon Cell No. 4. It is possible to remove any of the lagoon cells from service for maintenance purposes. Lagoon Cells 1, 2, and 3 have the original Hypalon 30 mil PVC liners and Lagoon Cell No. 4 has an 80 mil HDPE liner. The liners for Lagoon Cells 1, 2, and 3 are in need of replacement due to UV degradation. When holes are found in the liner, it is generally above the high water line, on the section of liner that is continuous exposed to the sun. The operator makes patches of these areas as needed. In 2017 a tear was found in the existing liner at the top of the slope that extended roughly 60-feet in length along the existing anchor trench. A liner installation company was hired to repair the liner in that instance. The liner for Lagoon Cell No. 4 is in good condition. The depths and volumes of the cells are shown in Table 5.

Table 5 - Lagoon Cell Depths and Storage Volumes

Lagoon Cell No.	Working Depth (ft)	Working Storage Volume (MG)	Total Storage Volume (MG)
1	0 – 9	0.0	0.57
2	2 – 11	7.7	9.0
3	2 – 15	7.8	8.6
4	4 – 21	26.3	30.6
Total		41.8	48.77

The irrigation season begins in April and ends in October of each year. As part of the management of the land application system, a crop rotation plan has been prepared. The crop plan is intended to provide guidance to the operator on when to remove the alfalfa crop and begin the process of re-establishing a new stand. A result of the crop rotation plan is that each year the allowable irrigation rate changes based on which field are currently planted in perennial alfalfa and which fields are planted in an annual oat (rotational) crop. A lagoon water balance has been included in Appendix C-1 for each year between 2018 and 2037. This lagoon water balance identifies the required lagoon storage volume assuming an influent growth rate of 4% over the next 20 years. The following Table 6 is a summary of the lagoon storage available, required lagoon storage, irrigation system capacity based on the crop rotation plan, and anticipated required irrigation volume for each year.

Table 6 - Lagoon Water Balance Summary

Year	Lagoon Storage Available (MG)	Required Lagoon Storage (MG)	Irrigation System Capacity (MG)	Required Irrigation Volume (MG)
2018	44.03	41.75	78.98	62.11
2019	44.03	42.08	84.12	64.35
Additional Lagoon Storage Required				
2020	44.03	45.48	73.34	66.69
2021	44.03	46.89	73.34	69.12
2022	44.03	46.92	80.93	71.65
2023	44.03	48.44	81.37	74.27
2024	44.03	49.42	84.55	77.01
Additional Irrigation Area Required				
2025	44.03	52.05	79.41	79.85
2026	44.03	53.77	79.41	82.80
2027	44.03	54.58	84.55	85.88
2028	44.03	58.47	74.21	89.08
2029	44.03	60.40	74.21	92.40
2030	44.03	60.97	81.80	95.86
2031	44.03	63.06	81.80	99.46
2032	44.03	64.63	84.99	103.20
2033	44.03	67.86	80.28	107.08
2034	44.03	70.21	80.28	111.13
2035	44.03	71.67	85.42	115.34
2036	44.03	76.26	74.64	119.71
2037	44.03	78.90	74.64	124.26

As indicated in the foregoing Table 6, in the year 2020 the wastewater inflow will exceed the lagoon storage capacity. At the extent of the nest 20 years planning cycle the City will need to add roughly 35 million gallons of storage to the system. Irrigation System Capacity is based on IWR values provided by IDEQ Staff Review of the reuse permit application. The Required Irrigation Volume is the volume of wastewater that needs to be applied to withdraw the lagoons down to the minimum operating depth every summer. The recent additions to the land application system will provide adequate irrigation capacity until the year 2025. By the end of the 20 year planning cycle the City will need to add roughly 50 million gallons in capacity to the land application system. The long term goal for the City is to locate a larger parcel of timber land suitable for construction of additional storage lagoons with adjoining areas for land application. The City is currently in discussions with the U.S. Forest Service on potential timber land for future lagoon storage and land application.

The values shown in Table 6 are predicated using the estimated annual ERU growth of 4%, 20% exceedance on average precipitation values, 80% exceedance on average evaporation values, a minimum lagoon depth of 4-feet due to the future addition of aerators in lagoon 4 and rotation of the crops as indicated.

D) LAND APPLICATION SYSTEM

Lagoon effluent is pumped out of the lagoons through the irrigation pump station located in the flow box and disinfected before being applied to the land application areas through sprinkler irrigation.

Wastewater effluent is used to irrigate crop and forested land at the City's land application areas. As the effluent is applied, it generally percolates downward through the soil. Theoretically, all of the effluent is taken up by the vegetation and released through evapotranspiration. Suspended solids are predominantly removed at the surface with biological, chemical, and additional physical treatment occurring as the soil infiltrates through the root/soil matrix. The application rate is controlled by the hydraulic capacity of the soil and the hydraulic uptake rate of the crop. Nutrient uptake by crops in the land application field provides further treatment. Crops are harvested and removed from the field in order to remove the nutrients. The land application step provides the final treatment and disposal component to the wastewater treatment process.

1) Irrigation Pump Station Control System

The irrigation pump station is located at the flow box and consists of two 25 HP vertical line shaft pumps capable of pumping 400 gpm each at 200-ft. of total dynamic head. These pump were replaced this past irrigation season. The irrigation pumps are currently activated manually. The operator manually starts the irrigation pumps along with the irrigation equipment in whichever field is selected to operate for the day. At the end of the irrigation cycle the operator manually turns the system off. The City is currently in process of constructing an automated irrigation control system that will allow the operator flexibility to turn the pumps on and off automatically based on a pre-selected application sequence. It is anticipated that this automation improvement will be ready for use prior to the 2018 irrigation season. The irrigation pumping equipment and control system are considered new condition.

All effluent pumped to the land application area is recorded by a flow meter immediately downstream of the irrigation pumps. The flow meter data will be transmitted to the plant computer and recorded for operator use.

2) Disinfection System

The disinfection system consists of a gas chlorination system. The major chlorination system components, including the chlorine gas cylinders, are housed within the chlorine room of the Operations Building. Chlorine solution is piped through an HDPE pipe from the chlorine room to the flow box. At the flow box, the chlorine solution is injected into the pump discharge piping. Adequate chlorine contact time is achieved in the effluent piping leading to the land application areas to maintain the permit limit of a maximum Total Coliform count of 23 org/100 mL within the effluent. This effluent piping includes a 36-inch diameter ductile iron pipe that extends from the edge of the lagoons near the common dike between Lagoon Cell Nos. 2 and 3 and extends directly towards the center of Center Pivot No. 1. The 36-inch pipe was installed in 2004 and extends parallel to the existing 21-inch pipeline to Center Pivot No. 1. The following Table 7 summaries the existing capacity of the chlorine contact piping at the wastewater treatment plant.

Table 7 - Chlorine Contact Pipe Capacity - Current

Pipe Section	Pipe Length (ft)	Pipe Volume (gal)	Contact Time at 800 gpm (min)
12" PVC	354	2,000	2.5
21" AC	1,020	18,114	22.6
36" DI	512	29,419	36.8
Total		**49,533**	**61.9**

It is proposed to continue the 36-inch ductile iron pipe from its current ending location out the remainder of the run to Center Pivot No. 1. In addition the City would like to add a 12-inch pipeline parallel with the 36-inch and 21-inch lines in order to force the wastewater to flow in a serpentine pattern to the Center Pivot No. 1 distribution location. This would entail directing the wastewater out via the existing 21-inch AC pipeline and then allowing the wastewater to flow back through the 36-inch ductile iron pipe and then back again to the center pivot distribution location via the 12-inch pipeline. This flow pattern would ensure against any short circuiting. The proposed chlorine contract pipe capacity would be as shown in Table 8 - Chlorine Contact Pipe Capacity - Proposed below. Construction plans for the chlorine contact pipe addition were reviewed and approved by DEQ on July 26, 2017.

Table 8 - Chlorine Contact Pipe Capacity - Proposed

Pipe Section	Pipe Length (ft)	Pipe Volume (gal)	Contact Time at 800 gpm (min)
12" PVC, CL 160 IPS	354	2,000	2.5
21" AC	1,002	17,830	22.3
36" DI, PC 150	512	29,419	36.8
36" DI Proposed, PC 150	490	28,156	35.2
12" PVC Prop., C900, DR18	1,060	5,866	7.3
Total		**83,271**	**104.1**

When the disinfection control panel is switched to the automatic position, the disinfection system operates with the activation of the irrigation pumps. The operator manually controls the chlorine solution feed rate depending on the free chlorine residual present in the effluent prior to irrigation. Total coliform tests are performed on a weekly basis to determine if disinfection levels set in the permit are being met.

3) Land Application Site

Effluent from the treatment process is pumped from the storage lagoons to the irrigation system during the summer months for final treatment and disposal. The Land Application Area is currently divided into five separate fields as shown on the Site Map in Figure 14 - Overall Wastewater Treatment/Disposal Facility. Specific properties of the Land Application Areas are listed in the following Table 9 - Land Application Area Properties.

Table 9 - Land Application Area Properties

Land Application Area	Hydraulic Unit	Area, AC	Irrigation	Assumed Irrigation Efficiency, %	Crop
Field No. 1	HMU-002-01	65	Center Pivot #1	85	Alfalfa or Spring Grain
Field No. 2	HMU-002-02	13	Center Pivot #2	85	Alfalfa or Spring Grain
Field No. 3	HMU-002-03	2.7	Hand Line Irrigation Laterals	75	Forest
Field No. 4	HMU-002-04	11	Hand Line Irrigation Laterals	75	Forest
Field No. 5	HMU-002-05	15	Hand Line Irrigation Laterals	75	Forest

Fields No. 1 and No. 2 are used for alfalfa or spring grain production. The City's Crop Plan recommends a two year rotation of the spring grain once the alfalfa crop has been depleted. Fields No. 1 and No. 2 are irrigated with center pivot circle irrigation systems which employ drop heads to apply the wastewater near the crop, thus reducing aerosol migration. Field No. 3 was previously irrigated with side roll wheel lines with impact sprinkler heads spaced 40' on center and which have a flow rate of approximately 5 -7 gpm each. The wheel lines have been removed, a large portion of Field 3 is now covered by Center Pivot No. 1 and the remainder will be converted to forest crop and irrigate with solid set sprinklers.

Field No. 4 consists of two forested sub-areas totaling 11 acres. These areas are irrigated with solid set aluminum sprinkler laterals with sprinklers spaced at 40' intervals along each irrigation lateral. The laterals are spaced 60' apart. The sprinkler heads are set 18" above the existing ground surface and deliver approximately 5 to 7 gpm each in an 80' diameter circle. Typical operation of the irrigation system utilizes the two main pumps, located at the flow box, which has a total pumping capacity of 800 gpm.

The newly acquired property west of Field 3 and north of existing Center Pivot No. 1 has been incorporated into the land application plan for the City. The southern portion of the new properly was cleared to allow operation of center pivot no. 1 further around the circle. This addition modifies irrigation Field No. 1 from a 44 acres site to now a 65 acre size. As part of this conversion the majority of irrigation Field No. 3 is now covered by Center Pivot No. 1. The northern ½ of the newly acquired property will remain in a forest crop and be referred to as Field No. 5. The irrigation main line routes and irrigation laterals have been cleared and installed. The irrigation system for Field No. 5 is similar to the forest irrigation for Field No. 4 with irrigation laterals at 60-ft on center, sprinklers at 40-ft on center along the lateral and sprinkler heads producing roughly 5 – 7 gpm per head. Field No. 5 encompasses an additional 15 acres of forest land application area.

4. *Financial Status of Existing Facilities*

In 2004 the City completed construction of the Lagoon Cell No. 4 expansion project. This project also constructed a new headworks facility. The City paid for a portion of this project with a DEQ loan. As of November 2017, the City has a remaining balance of $ 367,526.80 on the DEQ loan. Payments are made every January and July in the amount of $ 32,183.22 for a total annual loan payment of $64,366.44. The City intends on retiring this loan as part of the new loan to construct Lagoon Cell No. 5. The City does not currently have any other wastewater debt.

The current monthly residential sewer charge in the City of Spirit Lake is $26.00. The proposed monthly sewer rate is anticipated to increase to $ 28.00 per month with the proposed Lagoon Cell No. 5 project. The City would like to obtain a loan in the amount of $1,800,000 to construct Lagoon Cell No. 5 and pay off their existing DEQ loan in the amount of $ 367,526.80. The anticipated interest rate for the new loan is 3% with a term of 40 years. The annual payment on the $1,800,000 loan would be $77,940.00. The DEQ loan payment makes up approximately $5.08 of the monthly sewer charge as shown below.

$64,366.44 / 1055 ERUs / 12 months = $ 5.08 /ERU/Month

The proposed loan will require approximately $6.15 of the monthly sewer charge as shown below.

$77,940.00 / 1055 ERUs / 12 months = $ 6.15 / ERU/Month

The City has one required sewer reserve account totaling $ 24,000.00.

The following Table 10 lists the operation and maintenance expenses for Fiscal Year 2017 which ended on September 30, 2017. The column to the far right is a projection of the operation and maintenance expenses for the sewer system following construction of Lagoon Cell No. 5. This would represent Fiscal Year 2019 beginning October 1, 2018 and extending through to September 30, 2019. The expenses have generally been increased to represent a 2% per year inflationary increase with the exception of the projected power uses and debt service payment. The anticipated debt service payment has been included in this budget and the electrical usage has been increased to represent operation of the Lagoon Cell No. 3 aerators for the entire year.

Table 10 - Operation and Maintenance Expense Budget

Budget Item	Total Expense for FY 2017	Project Expense for FY 2019 (First Full Year After Construction)
Wages	$ 80,559.63	$ 83,782.00
Payroll Taxes	$ 5,662.66	$ 5,889.00
Workers Compensation	$ 4,988.00	$ 5,188.00
Medical Insurance	$ 21,541.59	$ 22,403.00
PERSI Retirement	$ 8,927.15	$ 9,284.00
Unemployment	$ 806.04	$ 838.00
Phone/Fax	$ 1,972.54	$ 2,051.00
Computer Expenses	$ 224.04	$ 233.00

Postage	$ 1,585.77	$ 1,649.00
Utilities	$ 5,321.48	$ 5,534.00
Testing	$ 7,090.00	$ 7,374.00
Power	$ 15,202.67	$ 24,306.00
Office Supplies	$ 848.68	$ 883.00
Operating Supplies	$ 12,602.32	$ 13,106.00
Fuel & Oil	$ 1,696.36	$ 1,764.00
Chlorine	$ 28,128.08	$ 29,253.00
Vehicle Expense	$ 987.40	$ 1,027.00
Publications	$ 1,165.05	$ 1,212.00
Code Publications	$ 114.59	$ 119.00
Dues & Subscriptions	$ 560.47	$ 583.00
Training/Seminars	$ 700.00	$ 728.00
Travel	$ 121.20	$ 126.00
Meals/Ent.	$ 40.75	$ 43.00
Audit Fees	$ 1,310.48	$ 1,363.00
Maintenance/Replacement	$ 43,881.21	$ 45,636.00
Lease/Rental Equipment	$ 1,457.99	$ 1,516.00
Legal Fees	$ 2,799.37	$ 2,911.00
Sewer Loan, Debt Service	$ 64,366.44	$ 77,940.00
Insurance	$ 3,552.81	$ 3,695.00
Backup Operator	$ 3,600.00	$ 3,744.00
Engineering	$ 20,715.75	$ 21,544.00
Impact Fee	$ 307.50	$ 320.00
Misc. Expense	$ 1,889.59	$ 1,965.00
TOTAL	$ 344,727.61	$ 378,009.00

Table 11 – **Estimated Revenue from Sewer User Fees**, below lists the revenue generated from the system based on monthly sewer user charges. Currently the monthly sewer fee is $ 26.00 per month. To date the City has 1,055 sewer ERUs which would generate a total of $ 327,240.00 in sewer user fees over the course of one year. The projected income has been listed as 1,141 ERUs contributing a proposed $28.00/month fee for a yearly total of $ 383,376.00. The increase in ERUs from 1,055 to 1,141 represents a 4% increase over a two year period. The City is currently realizing over 10% growth for 2017. It is proposed to curb growth to 4% to facilitate planning and implementation of infrastructure improvement projects. It is also proposed to eliminate the standby rate category as sewer expenses continue even under seasonal use of the system. Currently standby rates apply to seasonal users that request their water service be turned off for a portion of the year.

Table 11 – Estimated Revenue from Sewer User Fees

Equivalent Residential Users	Monthly Rate	Annual Income
(FY 2017) 1,039 ERUs	$ 26.00	$ 324,168.00
(FY 2017) 16 ERUs, standby	$ 16.00	$ 3,072.00
(FY 2017) TOTAL		$ 327,240.00

(FY 2019) 1,121 ERUs	$ 28.00	$ 376,656.00
(FY 2019) 20 standby users	$ 28.00	$ 6,720.00
(FY 2019) TOTAL		$ 383,376.00

The following Table 12 - Capital Improvement Plans, identifies the City's capital improvement plans for the wastewater treatment plant. The different projects are listed in priority. The first two projects are currently under construction and funded through connection and impact fees via the City's reserve account.

Table 12 - Capital Improvement Plans

Project	Amount	Status
Field 5 Booster Pump & Irrigation Automation	$ 423,400.00	City Funded & Currently Under Construction
Cells 3 & 4 Irrigation Intake Structures	$ 32,900.00	City Funded & Currently Under Construction
Lagoon Cell No. 5 Construction	$ 1,800,000.00	Design and Facility Planning Stage
Chlorine Contact Piping Expansion	$ 375,000.00	Designed & Bid in 2017, Inadequate Funding to Proceed
Lagoon Cell No. 4 Aeration	$ 75,000.00	Planning Phase
Field 4 – Manifold Piping	$ 75,000.00	Designed & Bid in 2017, Inadequate Funding to Proceed
Cell No. 2 Expansion, Relining, & Aeration	$ 1,200,000.00	Planning Phase
Cell No. 5 Aeration	$ 80,000.00	Planning Phase
Install new liner in Cells No. 1 and No. 3	$ 500,000.00	Planning Phase
Land acquisition for Cell No. 6 and Future Land Application Area	T.B.D.	Planning Phase

Table 13 below identifies the current user categories established within the City. The residential users provide the basis for defining an equivalent residential unit. The average daily sewer flow for one residential connection within the City is 140 gallons per day as noted in the following Table 14. The metered commercial connections are adjusted to equivalent residential units by dividing the monthly metered flow by the equivalent residential flow per connection. For the 5 metered commercial connections, enough flow is generated to equate to 13 residential connections. This calculation provides the basis for billing as well. The unmetered commercial connections are converted into equivalent residual connections by prescriptive assessments found in the City Code equating different commercial uses to residential equivalents. These can be found in City Code Title 7, Chapter 6, item #4.

Table 13 - Tabulation of Users by Monthly Use Categories As of 2017

User Type	Connections	ERUs Represented
301 – Residential	876	876
303 – Commercial	36	101
304 – Commercial-Metered	5	13

305 – Standby (Water Off)	27	27
306 – Public	1	1
Residential Currently Under Construction	37	37
Total	**982**	**1,055**

5. *Water/Energy/Waste Audits*

Each year the City conducts a review of the water and wastewater systems in their annual *Update to the Water and Sanitary Sewer Systems Capacity Analysis Report.* The capacity analysis reviews the status of each area of the water distribution system and sewage collection system. Historic flow data is presented identifying the average daily water use per connection; the maximum daily water use per connection, the average wastewater volume generated per connection, available lagoon storage capacity as well as growth and flow trends and obligated lots remaining within the City's service area. The capacity analysis reports have been conducted since roughly 2004. City administration utilizes this data to make decisions regarding the direction of future improvements. No other water/energy or waste audits have recently been completed.

6. *Equivalent Residential Units (ERUs) and Average Residential Flow Data*

Each year the City submits an annual report of their wastewater reuse operations. The data from than report along with ERU connection information obtain from City Hall was used to determine the average residential wastewater flow. The following Table 14 provides a summary of the growth within the city in terms of ERUs and the associated wastewater treatment plant influent. Over the period 2004 through 2016 the influent has averaged 140 gallons per day per ERU. Plant influent is measured by a flow metering flume located in the headworks facility. The influent volume for each day is calculated from the influent flume meter readings. Also shown is the plant effluent, or irrigation amount, in terms of ERUs. This number is generally higher than the influent per connection due to the precipitation that falls within the lagoon storage cells over the winter storage season. The plant effluent is recorded by an irrigation master meter located at the irrigation flow box, just downstream of the main irrigation pumps. The current lagoon configuration encompasses 15.5 acres. The precipitation collected over the storage season, October – May, is roughly 22.5 inches or 9.5 million gallons.

Table 14 - Summary of Spirit Lake Wastewater System Historic Flow

Year	ERUs	Annual Growth Rate (%)	Plant Influent (MG)	Influent (GPD/ERU)	Plant Effluent (MG)	Plant Effluent (GPD/ERU)
2004	595		34.5	159	31.1	143
2005	690	16.0	42.9	170	39.6	157
2006	741	7.4	38.1	141	38.1	141
2007	768	3.6	38.3	137	54.0	193
2008	784	2.1	39.8	139	48.4	169
2009	794	1.3	39.1	135	48.2	166
2010	805	1.4	38.5	131	52.9	180
2011	819	1.7	38.7	130	51.8	173
2012	830	1.3	37.4	123	50.0	165
2013	848	2.2	39.4	127	48.1	155
2014	853	0.6	47.2	151	50.6	163
2015	890	4.3	44.9	138	43.7	135
2016	954	7.2	48.0	138	43.6	125
2017	1055	10.6	53.7	139	59.6	155
Average		**4.6**		**140**		**158**

The average daily flow received at the wastewater treatment plant had been averaging approximately 106,000 gallons per day between the period 2007 through 2013. Over the past three years the average flow has jumped to approximately 128,000 gallons per day. The average flow, maximum monthly flow and maximum daily flow is presented in Table 15 - Summary of Spirit Lake Wastewater Daily Flow below.

Table 15 - Summary of Spirit Lake Wastewater Daily Flow

Year	**ERUs**	**Annual Average Daily Flow (gpd)**	**Maximum Month Flow (gpd)**	**Peak Day Flow (gpd)**
2007	768	105,024	116,858	262,500
2008	784	109,061	124,652	216,711
2009	794	107,146	118,290	145,606
2010	805	105,354	115,179	183,084
2011	819	106,159	123,731	245,034
2012	830	102,381	113,807	173,333
2013	848	108,000	134,187	152,459
2014	853	129,181	148,885	273,858
2015	890	123,128	135,673	209,688
2016	954	131,502	138,133	168,152
2017	1055	146,976	161,207	204,444

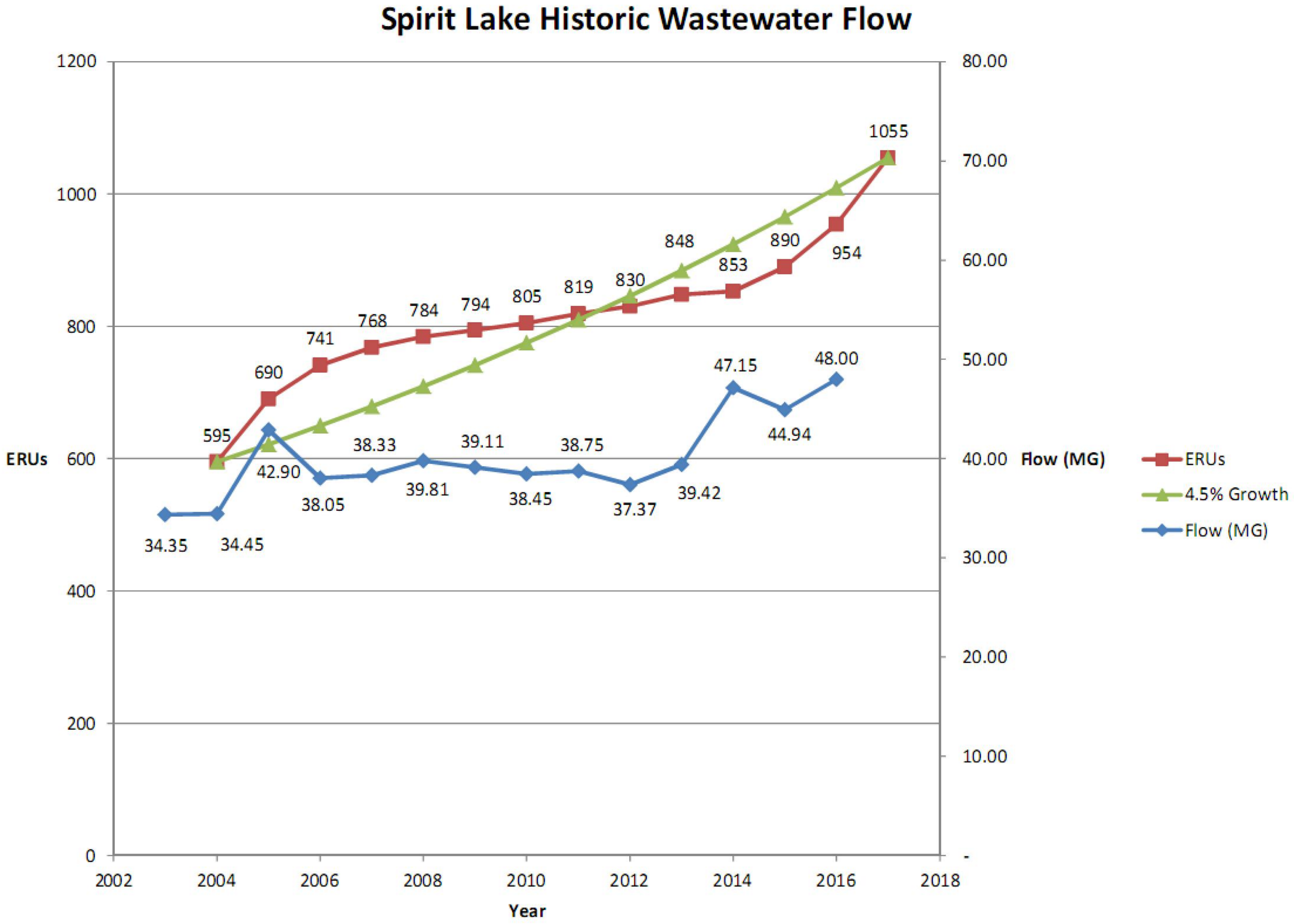


Figure 19 - Spirit Lake Historical Wastewater Flow Data.

Figure 19 - Spirit Lake Historical Wastewater Flow Data., above shows the number of residential connections moderately increasing between 2007 and 2014. Following 2014 the number of residential users on the system has increased significantly. The green line in the prior graph represents a 4.5% growth rate beginning in 2004 through 2017. From Figure 12 prior the average population growth in Spirit Lake is around 4% over the past 26 years. This closely follows the ERU growth rate of 4.5% noted in Figure 19 above. For future planning a growth rate limited to 4% per year is recommended.

Measurement of the annual flow received for 2013 were impacted due to the plug valve replacement project which backed up water in the headworks flume for several months during that construction. In addition, in late 2013, the influent flow meter was recalibrated and the City's annual report notes that the prior meter readings for 2013 were questionably low. Beginning in 2012 the wastewater flow received at the facility began to increase. The average increase in wastewater flow received at the plant between 2012 and 2016 equates to approximately 7% per year.

D. Need for Project

1. *Health, Sanitation, and Security*

A) LAGOON STORAGE

During the 2017 irrigation season the City worked closely with IDEQ to irrigate and track lagoon volumes. This coordination was prompted by the lagoon levels realized during the spring months prior to irrigation. In April and May of 2017 the lagoon levels were at the flooded condition. The flooded condition is when the water levels in each lagoon cell reach the overflow pipes which extend through the dike between the cells. This elevation is roughly 2-feet below the top of the dike. When the lagoons are flooded the operator does not have control over the treatment process or where the incoming wastewater flows. The lagoons are generally designed to operate with 3-feet of freeboard above the maximum water surface and below the top of the dike. Recent growth and record rainfall during October of 2016 compounded the lagoon storage problem. IDEQ issued a temporary permit to irrigate over land that contained a public water system mainline. IDEQ issued a permit modification to add 15 acres of timber land to the land application system. IDEQ also issued a one-time approval to irrigate above the Irrigation Water Requirement of the crop during late summer/early fall to facilitate emptying the lagoon cells prior to the storage season. Two times during 2017 the City issued a moratorium on new sewer connections which is currently in effect. During 2017 the City made substantial efforts to mitigate overfilling of the lagoon cells during the upcoming 2018 winter storage season. Over-filling of the lagoon cells could result in overtopping the lagoon dikes and spilling wastewater onto the ground above the Rathdrum Prairie – Spokane Valley Aquifer. The need for additional lagoon storage was evident during the 2017 season. Correspondence with IDEQ regarding irrigation application and lagoon storage accounting is included in Appendix D-1.

B) BIOLOGICAL TREATMENT

The plant biological treatment is achieved through aeration and detention time. In general, the aeration capacity of the Spirit Lake wastewater treatment plant has historically been deficient as noted in the prior section titled *Condition of Existing Facilities*. The recent increase in flow has resulted in a lessening of the detention time through the plant. The addition of Lagoon Cell No. 5 will add storage and increase the overall detention time through the facility. Installation of aeration in Lagoon Cell No. 4, Lagoon Cell No. 2 and proposed Lagoon Cell No. 5 will greatly enhance the plant capacity to achieve biological treatment.

2. *Aging Infrastructure*

A) INFILTRATION/INFLOW

Infiltration occurs when seasonal groundwater levels rise and submerge portions of the collection system. Groundwater infiltrates into the collection system through defective pipes, joints, connections, or manholes. Infiltration is normally quantified during dry periods that occur when the groundwater elevation is highest. For the City’s wastewater collection system the likelihood of infiltration is very slight. The groundwater elevation is generally

450 - 500 feet below the ground surface in most areas of the City and does not appear to rise to submerge the collection system components at any point within the system.

Inflow occurs during the wet season and is a result of water other than sanitary flow entering the system through leaking manholes, roof leaders, cellar drains, yard drains, area drains, surface runoff or other unauthorized stormwater drainage connections. The monthly flows received at the wastewater treatment plant were analyzed for the period 2007 through 2016. The summer time/dry season average flow which occurs between June and September each year were compared with the winter time/wet seasons average flows. The wet season flows averaged 6.8% higher than the dry season flows. The wet season peak day flows were divided by the population and resulted in an average of 110 gallons per day per person with the peak of 153 gallons per day per person occurring in 2007. The regulatory limit is usually set at 275 gallons per day per person. The inflow realized at the City's wastewater treatment plant is well below typical regulatory limits and therefore is not considered a substantial impact to the plant capacity.

B) TREATMENT AND STORAGE

The treatment capability is generally achieved through aeration of the incoming wastewater and providing adequate detention time to allow treatment to occur. In the final steps of the process, wastewater is disinfected prior to land application. The City's wastewater treatment plant has struggled with the beginning stages of the treatment process due to insufficient aeration which results in wastewater that is only partially treated. As a result, the disinfection process becomes much more difficult. Commonly, it is easier to disinfect fully treated wastewater as opposed to partially treated wastewater. Partially treated wastewater contains higher nitrogen concentration and significant suspended solids that act to tie up the chlorine used for disinfection. The pathogens that the disinfection process is targeting can be hidden and masked in the suspended solids and hidden from the disinfection process. The recent addition of aeration in Lagoon Cell No. 3 will provide needed treatment capacity. The proposal to add Lagoon Cell No. 5 will increase the system detention time and also help the treatment process.

The available reserve storage capacity that was previously available in the lagoon storage cells are now utilized by growth that has recently occurred within the service area. The lagoon storage shortage and need has been defined prior in section *C-Existing Facilities, 3.0 Condition of Existing Facilities*. In summary, the City will need to add an additional lagoon cell for storage purposes by 2,019 and the total storage system capacity will need to increase by 35 million gallons by the end of the 20 year planning period, 2037 if the predicted growth rate occurs.

C) INEFFICIENT DESIGNS

The land application portion of the wastewater treatment/disposal facility has been expanding in recent years. The reuse/land application system contains five fields for irrigation of treated wastewater. The system is currently operated manually by the plant operator. As the system has grown it has become increasingly more complicated to track wastewater application and evenly apply wastewater to each of the fields. Each field is different in size and irrigation flow rate. The current irrigation system requires the operator run multiple fields at the same time in order to match crop irrigation water requirements and to ensure the lagoon cells are empty at the end of the application season. This was a seven day per week effort during the last irrigation season. To alleviate the current operational challenges, the City is currently installing flow metering and automation equipment to track application to each field and facilitate scheduling activation and shutdown of the system automatically.

3. Reasonable Growth

This planning document and the recently prepared Water Facility Plan for the City of Spirit Lake have been completed based on the assumed future growth rate of 4% per year. Growth within the City has surpassed the 4% figure over the past two years and this has left the City scrambling to keep up on infrastructure improvement projects. Limiting growth to 4% per year in the upcoming years will allow the City time to plan projects, receive regulatory approval, and obtain funding without the need to implement zero connection moratoriums.

The proposed Lagoon Cell No. 5 project will add approximately 17 million gallons of total storage capacity to the wastewater treatment system. The lagoon storage capacity following installation of Lagoon Cell No. 5 will increase to 1,595 ERUs. At a 4% growth rate the overall wastewater storage system will be at capacity by the year 2027.

4. Compliance with State and Federal Regulations

The proposed improvements described herein will be conducted and implemented under the regulatory approval of the Idaho Department of Environmental Quality who issues the permit for operation of the wastewater treatment facility.

E. Alternatives Considered

1. Description

A) LAGOON STORAGE

The alternatives reviewed for increasing the City's lagoon storage capacity are as follows:

1) **No Action**
2) **Construct a new Lagoon Cell No. 5 north of existing Lagoon Cell No. 2**
3) **Construct two new lagoon cells north of existing Lagoon Cell no. 2.**
4) **Construct a new Lagoon Cell No. 5 on City property west of the current lagoon cells**
5) **Expand and deepen existing Lagoon Cell No. 2**

1) No Action

The No Action alternative includes maintaining the status quo. This alternative would not add lagoon storage to the existing system or address improvements to the treatment system through added detention time at the treatment plant. Under the No Action alternative, operation at the treatment facility would look similar to this past 2017 irrigation season when lagoon volumes were flooded in the spring, and application of wastewater throughout the summer was at or above permit limits. Under the No Action alternative additional connections to the system would only add to the lagoon storage and treatment inadequacy. Operation under the No Action alternative could potentially have detrimental environmental impacts if the lagoon cells were overtopped and untreated wastewater spilled onto the ground, returning prematurely to the groundwater cycle.

2) Construct a new Lagoon Cell No. 5 northerly of existing Lagoon Cell No. 2, S1 (Storage Option 1)

The City recently purchased property just north and adjacent to Lagoon Cell No. 2. Two lots were purchased from the Spirit Lake Industrial Park with the intention of providing land for a lagoon storage cell. These lots are approximately 6 acres total in size and were previously used as a borrow pit and then shooting range. The site has previously been disturbed and is set with topography sloping from the south, uphill to the north. The center of the property has previously been utilized as a sand pit where borrow materials were hauled offsite. After the borrow activity ceased, the site was utilized by a gun club/ short distance target shooting range. The southern and lower elevations of the site appear to be areas where previous activity included dumping of miscellaneous construction debris. Due to the nature of the site the lagoon construction would include excavation into the existing hillside / borrow area to create Lagoon Cell No. 5. The earthwork to complete the lagoon construction would entirely be excavation and export excavated materials to a nearby stockpile site. Very little of the site would require fill and embankment construction. The lagoon base elevation would be set at 2368.00 which is slightly lower than the top of the existing dikes surrounding Lagoons Cells No. 1 - 4, (Elev. 2370.60). The proposed Lagoon Cell No. 5 would have a top elevation of 2389.00 with a maximum water depth of 18 feet. The total volume at 18-feet in depth would be just over 17 million gallons.

Wastewater would be pumped to this lagoon cell for storage via the irrigation pumps in the flow box. A new distribution line would extend from the west end of the Lagoon Cell No. 3 dike to the southwest corner of Lagoon Cell No. 5. A gated transfer pipe would be installed between Lagoon Cell No. 2 and the new lagoon cell to allow water to flow via gravity back to Lagoon Cell No. 2.

The proposed lagoon would be constructed to allow installation of lagoon aeration equipment at a later date. This would include installation of underground electrical conduits and junction boxes as well as installation of aerator mooring anchors in the lagoon dikes. Early installation of the aerator infrastructure will mitigate the need to cut into the lagoon liner in the future to install mooring anchors and electrical conduits.

The proposed lagoon would be lined with two layers of 60 mil HDPE liner and a leak detection system. The leak detection system would include a means of visually inspecting whether water is collecting between the two liner layers. In addition, electrical grounding probes would be installed between the two liner layers in order to conduct electric leak location surveys of the primary lagoon liner in the future.

The proposed lagoon would be constructed with a chain link fence surrounding the lagoon similar to Lagoon Cells No. 1 – 4.

The proposed lagoon cell is located on property originally platted as the Spirit Lake Industrial Park. Setbacks to residential properties are defined under IDAPA 58.01.16 section 450.c as 300 feet for lagoons open to the atmosphere. The properties surrounding the proposed lagoon site do not include any potential residential development. Directly south and west of the site are properties owned by the City of Spirit Lake and utilized as part of their wastewater treatment and disposal facilities. Directly to the north and east of the proposed site are dedicated public rights-of-ways for Industrial Park Avenue and Coyote Avenue. To the north beyond Coyote Avenue is Spirit Lake Industrial Park (SLIP) Lot 6C of Block 1 which is used by a cedar cabin manufacturer. Directly to the east beyond Industrial Park Avenue is SLIP Lot 1 of Block 2 which is designated the utility lot for the SLIP and houses the SLIP Water System water reservoir. The Idaho State Highway 41 right-of-way borders the east side of the SLIP utility lot. The nearest residential lot to the proposed Lagoon Cell No. 5 site is located on the east side of State Highway 41 and is over 430 feet to the east of the proposed lagoon.

3) Construct two new lagoon cells north of existing Lagoon Cell No. 2, S2 (Storage Option 2)

This alternative is similar to the previous alternative; however in this option we have investigated the concept of two lagoons instead of one to try and make better use of the land available for construction. The two proposed lagoon cells would be constructed on the recently purchase property just northerly of Lagoon Cell No. 2. These lagoon cells would be smaller in size and at differing elevations. The proposed cell located furthest to the south would have a base elevation of 2368.00 and a top of dike elevation of 2390.00. The second of the proposed lagoon cells would be north of the first cell and have a base elevation of 2390.00 and a top elevation of 2410.00. These cells would have individual volumes of 7.24

million gallons (MG) for the southern cell and 6.49 MG for the northern cell when they are filled to within 3-feet of the top of the dike. Together they would provide a total of 13.73 MG.

The proposed lagoon cells would be constructed to allow installation of lagoon aeration equipment at a later date. This would include installation of underground electrical conduits and junction boxes as well as installation of aerator mooring anchors in the lagoon dikes.

The proposed lagoon cells would be lined with two layers of 60 mil HDPE liner and a leak detection system. The leak detection system would include a means of visually inspecting whether water is collecting between the two liner layers. In addition, electrical grounding probes would be installed between the two liner layers in order to conduct electric leak location surveys of the primary lagoon liner in the future.

The proposed lagoon cells would be constructed with a chain link fence surrounding the lagoons similar to Lagoon Cells No. 1 – 4.

4) Construct a new Lagoon Cell No. 5 on City property to the west of the current lagoon cells, S3 (Storage Option 3).

In this alternative the City would utilize properly currently part of the land application area to site an additional lagoon cell. This alternative would allow for installation of a lagoon cell at the same elevation as the existing four lagoon cells. Conveyance of wastewater between the lagoon cells would be completed through installation of transfer piping between the common dike of the new lagoon and the existing cells. In this alternative the lagoon size is not impacted by property boundaries. A lagoon could be constructed large enough to facilitate the 20 year planning period, or roughly 35 MG in size. This alternative would require approximately 14 acres of land for lagoon construction

The proposed lagoon would be constructed to allow installation of lagoon aeration equipment at a later date. This would include installation of underground electrical conduits and junction boxes as well as installation of aerator mooring anchors in the lagoon dikes.

The proposed lagoon would be lined with two layers of 60 mil HDPE liner and a leak detection system. The leak detection system would include a means of visually inspecting whether water is collecting between the two liner layers. In addition, electrical grounding probes would be installed between the two liner layers in order to conduct electric leak location surveys of the primary lagoon liner in the future.

The chain link fencing surrounding the existing Lagoon Cells No. 1-4 would be expanded to incorporate the proposed lagoon cell.

5) Expand and deepened existing Lagoon Cell No. 2, S4, (Storage Option 4)

This alternative would include reconstruction of Lagoon Cell No. 2 to utilize and take advantage of areas where the lagoon could be expanded to the northeast of the lagoon cell. To the northeast of the lagoon cell and south of the abandoned railroad grade there exists approximately ¾ of an acre of unused land adjacent to Lagoon Cell No. 2. In addition, Lagoon Cell No. 2 was constructed to a total depth of 14-feet. Through reconstruction of the cell, it would be deepened to 18-feet, consistent with Lagoon Cell No. 3. By expansion and deepening of Lagoon Cell No. 2 the total volume would increase from 9 MG to approximately 14 MG.

The piping system serving Lagoon Cell No. 2 would remain at its current location. However, new piping would replace the existing piping, the interconnection with the flow box would remain the same, and the locations for the incoming and outgoing lines would also remain the same.

Lagoon Cell No. 2 reconstruction would include installation of conduit and aerator mooring anchors to facilitate future installation of aeration equipment.

The existing liner in Lagoon Cell No. 2 was installed with initial construction of the wastewater treatment plant in the early 1980s. The existing liner is 30 mil thickness, and constructed with 3-foot wide strips welded together. Replacement of the existing liner would be considered a significant improvement to the plant. A new liner system would be installed in the reconstructed Cell No. 2 and would include two layers of 60 mil HDPE liner with a leak detection system. The leak detection system would include a means of visually inspecting whether water is collecting between the two liner layers. In addition, electrical grounding probes would be installed between the two liner layers in order to conduct electric leak location surveys of the primary lagoon liner in the future.

B) WASTEWATER TREATMENT

Several alternatives for improving the treatment capability at the wastewater treatment/disposal facility have been reviewed and they include:

1) **No Action**
2) **Expand the Chlorine Contact Piping System**
3) **Install Aeration in Lagoon Cell No. 4**
4) **Install Aeration in Lagoon Cell No. 2**
5) **Install Aeration in proposed Lagoon Cell No. 5**
6) **Convert the Plant to Mechanical Treatment**

1) No Action

The No Action alternative includes maintaining operation as is. This alternative would not address improvements to the treatment process through additional aeration or enhancements to the plant disinfection capability. During 2017, treatment/disposal capacity issues hindered the plant operation is several primary ways. The initial and primary issue is the reduction in irrigation pumping capacity. In order to meet the disinfection requirements the irrigation flow rate has to be reduced in order to inject sufficient chlorine to properly disinfect the irrigation water. The facility irrigation system is designed for a hydraulic capacity of 800 gallons per minute. During 2017 the irrigation rate had to be reduced to 400 gallons per minute or less in order to meet the disinfection limits. The required irrigation rate reduction caused substantial additional effort to irrigate over the summer.

The second way inadequate treatment affected the facility in 2017 was excess application of nitrogen to the forest crops. The effluent nitrogen concentrations represented previously in Figure 18 are at levels expected with untreated wastewater. This is indication that the treatment process is inadequate in reducing the nitrogen concentration. The No Action alternative would continue operation in the same manner as previously conducted, and the results are anticipated to be continued challenges with meeting both nitrogen limits and disinfection limits.

2) Expand Chlorine Contact Piping System, T1 (Treatment Option 1)

Expansion of the chlorine contact piping system would provide several improvements to the wastewater facility treatment capabilities. This alternative would help address the issues associated with meeting proper disinfection limits during the irrigation season. The chlorine contact piping network currently includes a 21-inch asbestos cement pipe extending approximately 1,000 feet between the lagoon cells and the booster pump/irrigation distribution manifold at Center Pivot No. 1. Also existing is a parallel 36-inch ductile iron pipe extending approximately 500 feet from the lagoon cells toward the distribution manifold at Center Pivot No. 1. The 36-inch line stops at the halfway point and is connected back into the existing 21-inch line. The proposed upgrade would include extension of the 36-inch contact line the remaining 500 feet to the distribution manifold. A third 12-inch line would be added parallel to the 36-inch line creating three parallel lines extending between the lagoon cells and the irrigation distribution manifold. By installing three parallel lines the plant effluent would be forced to flow away from the lagoons through the 21-inch line, then flow back toward the lagoons through the 36-inch line, and then finally flow back to the irrigation distribution manifold through the 12-inch line. In this way the possibility of wastewater short circuiting through one of the lines would be eliminated. This operational scenario would ensure that all wastewater receives the same amount of contact time.

This addition to the contact piping would increase the provided contact time from approximately 62 minutes to 104 minutes. As part of the normal daily operation of the plant, the operator tests the free chlorine residual in the effluent at the outlet of the contact chamber and prior to irrigation. On several occasions during the 2017 irrigation season, the plant operator has conducted free chlorine residual bench tests to determine if additional contact time would be beneficial. These tests are conducted by taking samples at the end of the contact chamber and then allowing them to sit on the bench in the lab until they show a bright pink color. The higher the free chlorine residual the darker pink the sample becomes. During these tests, the free chlorine residual in the samples was strongly evident approximately 20-30 minutes after the samples were tested, which indicates that additional contact time would prove favorable.

3) Install Aeration in Lagoon Cell No. 4, T2

Lagoon Cell No. 4 was originally constructed in 1994 and then expanded in 2003. During the expansion of Lagoon Cell No. 4, aeration erosion pads were installed as well as aeration mooring anchors. Underground electrical conduit was installed to each aerator location with the plan of future installation of aeration equipment. During 2016 the City purchased 23 used lagoon surface aerators from the town of Fruitland, Idaho. The underground infrastructure, the aerator mounting and anchoring system, and the aerators are all ready for installation. The items remaining to complete to facilitate installation of aerators in the Lagoon Cell No. 4 include:

a) Place the aerators in the lagoon cell,
b) Install the shoreline electrical disconnect equipment,
c) Install the conductors between the plant Motor Control Center in the Control Building and the aerator locations at Lagoon Cell No. 4,
d) Reconstruct the east ½ of the Motor Control Center to facilitate service to four more lagoon aerators.

The additional aerators would each be 10 horsepower in size and be capable of adding a total of 960 lbs. of oxygen to the treatment process each day which would substantially improve the overall treatment capability. Cell No. 4 is roughly 20-feet deep when full, and the addition of aeration equipment would also assist in mixing the lagoon cell and eliminating stagnant and septic water that stratifies at the bottom of the lagoon cell.

4) Install Aeration in Lagoon Cell No. 2, T3 (Treatment Option 3)

Lagoon Cell No. 2 is generally the second step in the hydraulic flow pattern through the lagoon cells at this facility. Lagoon Cell No. 1 is aerated, after which wastewater flows to Lagoon Cell No. 2 for storage. Lagoon Cell No. 1 is 570,000 gallons in size and the average wastewater flow entering the plant is approaching 150,000 gallons per day. At this flow rate, Cell No. 1 provides an average detention time of 3.8 days, which is generally considered too short for adequate treatment. Typical aerated lagoon design parameters generally include 10 days of detention time. Reconstruction of Lagoon Cell No. 1 to provide additional detention time is not possible due to limited space available. However, Lagoon Cell No. 1 is beneficial by allowing a portion of the settleable solids to be retained in this cell. Installation of aeration equipment in Lagoon Cell No. 2 would extend the initial aerated segment of the treatment process to approximately 60 days.

Lagoon Cell No. 2 has a 14-foot total depth and the bottom of the lagoon contains a sand layer covering the existing liner. The maximum water depth in Lagoon Cell No. 2 is approximately 12-feet. Operation of aeration equipment in Lagoon Cell No. 2 would require a minimum of 7-feet of water depth to prevent erosion of the underlying sand layer. Four each 10 horsepower aerators would be installed in Lagoon Cell no. 2 which would equate to approximately 4.4 HP/MG in Cell No. 2. Aerator installation would require installation of aerator mooring anchors, electrical conduits and electrical disconnect equipment. The existing Motor Control Center in the Control Building would need to be expanded to provide service for four additional aerators. It is anticipated that expansion of the existing Motor Control Center to serve Cell No. 2 aeration needs would take up the usable space for electrical equipment in the existing Control Building. Expansions beyond this expansion of the Motor Control Center would require an addition to the building.

Ideally, plans to expand Lagoon Cell No. 2 would be completed prior to plans for installation of aeration equipment in the existing lagoon. This would mitigate the need to relocate and reconstruct the mooring and electrical infrastructure serving the aerators. In addition, the minimum water depth would be reduced to 4-feet from 7-feet due to the elimination of the sand layer above the old liner. During the Cell No. 2 reconstruction a new HDPE liner would be installed and the cell would be deepened by 4-feet. This would create additional storage and allow the aeration equipment to be activated when the lagoon depth is at 4-feet instead of 7-feet.

5) Install Aeration in proposed Lagoon Cell No. 5, T4

Proposed Lagoon Cell No. 5 is proposed to be constructed with the intention of installation of aeration equipment at some point in the future. Cell No. 5 aeration would include four (4) 10-horsepower aspirating floating aerators. Lagoon Cell No 5 is generally proposed to be 21-feet deep with a maximum water surface depth of 18 feet. Aeration in Lagoon Cell No. 5 would assist in aeration as well as mixing of the bottom of the lagoon cell that will tend to stratify without aeration during periods when the cell is filled to capacity. Four 10-horsepower aerators would add roughly 960 lbs. of oxygen per day to the treatment system which would enhance the overall treatment capacity of the facility. Electrical service for aerators in Lagoon Cell No. 5 would originate from the Motor Control Center. Expansion of the Motor Control Center would be necessary to add capacity to serve additional motors. As discussed in the prior alternatives, the capacity to expand the Motor Control Center is limited due to space available.

6) Convert the Plant to Mechanical Treatment

Replacement of the existing wastewater treatment facility with a mechanical treatment facility would include the following equipment and processes:

- Elimination of Lagoon Cell No. 1,
- Installation of a concrete aeration basin with mechanical aeration and mixing,
- Installation of duel concrete clarifiers,
- Installation of a chlorine contact basin,
- Installation of a waste activated sludge and return activated sludge pumping facility,
- Installation of an aerobic digester for waste sludge,
- Installation of a sludge dewatering facility,
- Expansion of the plant electrical service,
- Expansion of the plant control system,
- And expansion of the plant motor control center.

The mechanical treatment plant would provide the treatment currently designed to be achieved in the aerated treatment lagoons. The existing headworks facility would remain in service to screen out the incoming rags, trash and the non-biodegradable materials received. The mechanical plant would continuously treat the incoming wastewater and provide disinfected treated water for storage and reuse on the land application sites. The existing lagoons would be utilized for storage over the winter period, similar to their current use and the land application areas would be irrigated over the growing season just as is currently done.

The largest deterrent to installing a mechanical treatment plant at the City's wastewater treatment and disposal facility is the initial capital cost. A conservative estimate of costs to install a 500,000 gallon per day plant would be close to 10 million dollars. Outside of a substantial capital cost, the mechanical treatment facility would also require full time operation and operator Class 3 certification. A mechanical plant is much less forgiving compared to the current system and is much more complicated from an operational standpoint. For these reasons the option of replacing the existing facility with a mechanical plant will not be considered further.

C) LAND APPLICATION / REUSE SYSTEM

The City has recently completed several projects during 2017 which expanded the land application system capacity. An additional 30 acres of application area was added in 2017 which included a project to clear, fence and install irrigation distribution infrastructure. Currently the City is constructing a Field No. 5 booster pump station with capability for automation and scheduling of the irrigation system. As part of the 2017 irrigation system expansion projects, one project remains which was put out to bid in 2017 but rejected by the City due to lack of funds. That project includes installation of a new piping manifold to serve Field 4. A description of that project and the No Action alternative are as follows:

1) No Action

The No Action alternative includes continuing use of the existing 6-inch distribution pipeline serving both Fields No. 2 and No. 4. The No Action alternative requires multiple days of operation to cover these fields with adequate sprinkler pressure due to the inadequate size of the 6-inch pipeline.

2) Install new piping manifold to Field No. 4

This alternative would provide a separate 10-inch pipeline to supply irrigation water to Field No. 4. In the updated operation sequence for the irrigation system, the entirety of Field No. 4 will be irrigated at one time. This will simplify the operation and application tracking in that irrigation to Field No. 4 will apply one day every five days and all of the field will be covered at the same time. The flow rate to irrigate all of Field No. 4 is roughly 850 gallons per minute. The proposed pipeline would be approximately 1,600 feet in length. The associated headloss at this distance and flow rate through the existing 6-inch pipeline is just over 100 feet, which is much too high for proper operation. The proposed pipeline would extend from the irrigation distribution manifold at Center Pivot No. 1 and proceed south across Fields No. 1 and No. 2. The new pipeline would connect into the existing 6-inch pipeline just prior to the Spirit Creek crossing and beginning of the irrigation laterals for Field 4. With this pipeline addition, the headloss will be substantially reduced, allowing proper operation.

3) Convert to surface water discharge

Converting the disposal component of the City's wastewater treatment facility would include replacing the land application/reuse site with a surface water discharge. A surface water discharge would be an outlet for the plant effluent into a receiving stream. Generally surface water discharges can be utilized year round and the need for winter storage would be eliminated. A surface water discharge could also eliminate the need for additional acreage as the city population grows and expands. The nearest creek to the wastewater treatment facility is Spirit Creek. Spirit Creek is a seasonal creek that flow during year of high runoff.

Spirit Creek originates at the outlet of Spirit Lake near the north end of the mill pond. It is common that Spirit Creek will not flow for years at a time. The next closest creek is Spring Creek, which is a year round small stream. Spring Creek and the Spirit Creek channel converge about 500 feet west of Field No. 1 on private property. From that point the creek continues north approximately 1 mile before is disappears into the ground and eventually the aquifer.

The option of surface water discharge has previously been presented to the IDEQ. The major issues with a surface water discharge for the Spirit Lake Wastewater Treatment and Disposal Facility include the lack of a large year round stream or river as the receiving water, the facility location over the Rathdrum Prairie Aquifer and the idea that the existing streams disappear to recharge the aquifer in close vicinity to the facility. For these reasons a surface water discharge would not be permitted.

2. Design Criteria

The design parameters used to evaluate the wastewater treatment/disposal facility improvement alternatives include the following regulations and guidance documents:

i) IDAPA 58.01.17 – Rules for the Reclamation and Reuse of Municipal and Industrial Wastewater
ii) Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater - IDEQ
iii) Recommended Standards for Wastewater Facilities (Ten States Standards)

Lagoon storage design parameters include the following:

i) Minimum separation from high groundwater	4-feet
ii) Minimum separation from bedrock	10-feet
iii) Minimum freeboard above maximum water elevation	3-feet
iv) Dike road width, minimum	16-feet
v) Lagoon side slopes, H:V, maximum	3:1
vi) Lagoon side slopes, H:V, minimum	4:1
vii) Maximum water depth,	18-feet
viii) Pond Liner Layers	2
ix) Pond Liner Material	HDPE
x) Pond Liner Thickness	60 mil

Wastewater treatment design parameters include the following:

i) Aerator oxygen transfer rate	1 pound/HR/HP
ii) Influent BOD_5 concentration	220 mg/l
iii) Influent Total Nitrogen concentration	40 mg/l
iv) Oxygen Required for BOD_5 oxidation	1.1 lbs. O_2/BOD_5
v) Oxygen Required for Nitrogen oxidation	4.6 lbs. O_2/N
vi) Extended aeration peak factor	1.5

3. Site Plan/Schematics

A) LAGOON STORAGE

1) Construct a new Lagoon Cell No. 5 north of existing Lagoon Cell No. 2, S1

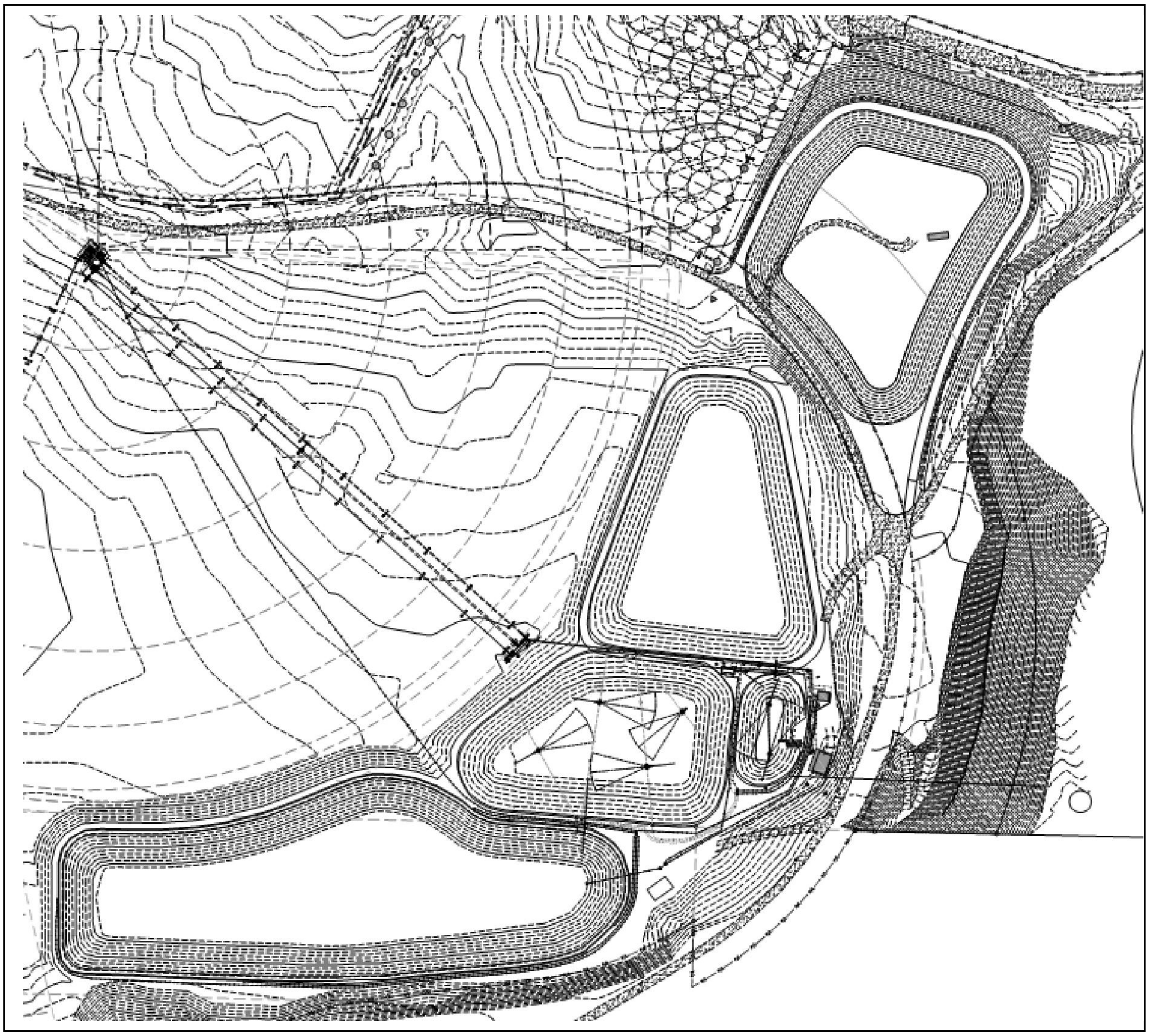


Figure 20 - Proposed Lagoon Cell No. 5 Location, S1

Figure 20 shows the option of constructing a new Lagoon Cell No. 5 on property north of Cell No. 2. This layout positions the new lagoon cell just north of the existing railroad embankment and allows for future expansion of Lagoon Cell No. 2 to the south of the old railroad bed.

Proposed
Cell 5

Cell 2

2) Construct two new lagoon cells north of existing Lagoon Cell no. 2, S2.

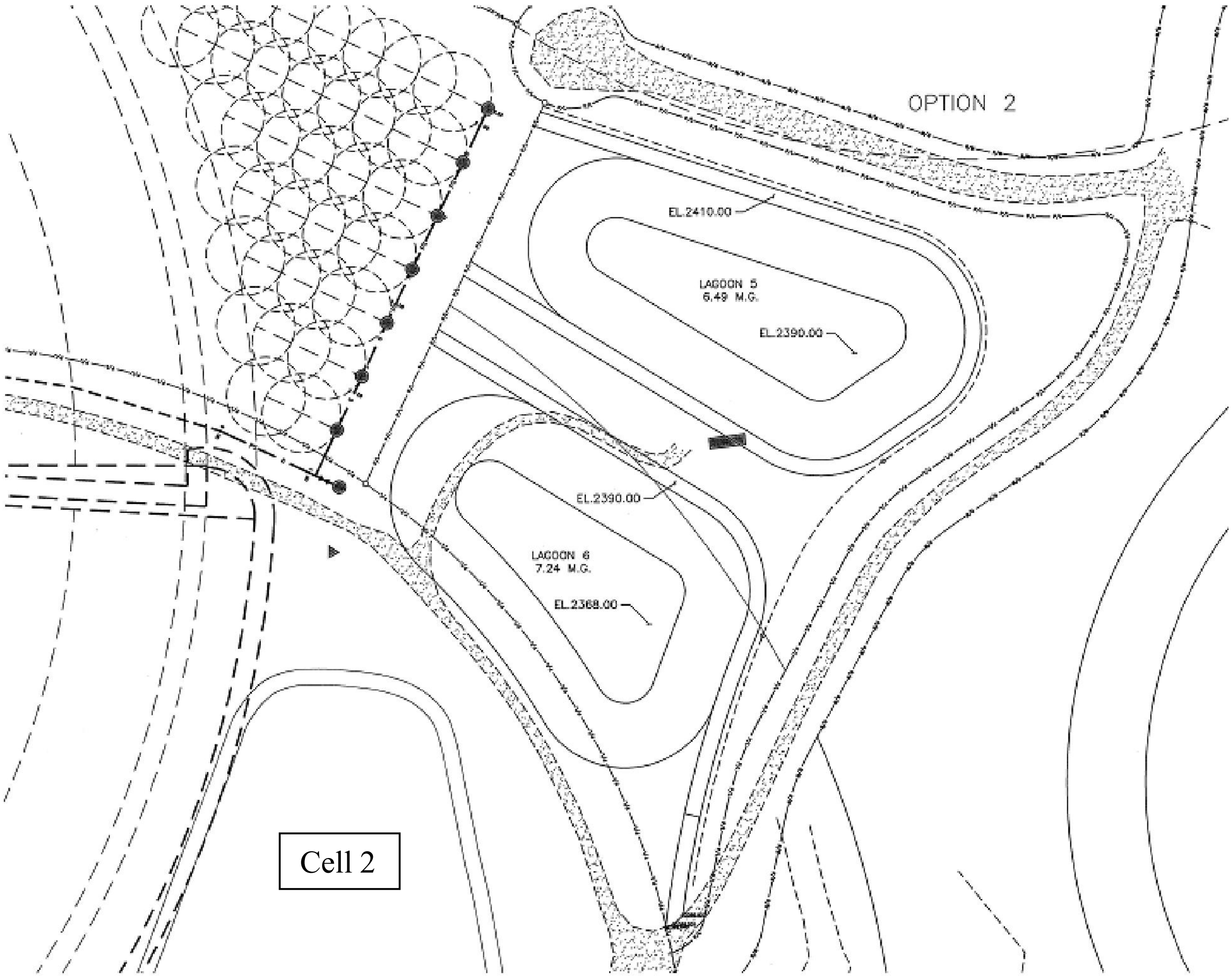


Figure 21 - Proposed Lagoon Cells No. 5 & No. 6 Location, S2

Figure 21 utilizes the same property as the previous option. In this alternative two lagoons have been placed on the property in an effort to better utilize the land available. The property slopes downhill from the north to the south. These two lagoons are terraced into the hillside to minimize the earthwork required.

3) Construct a new Lagoon Cell No. 5 on City property west of the current lagoon cells, S3

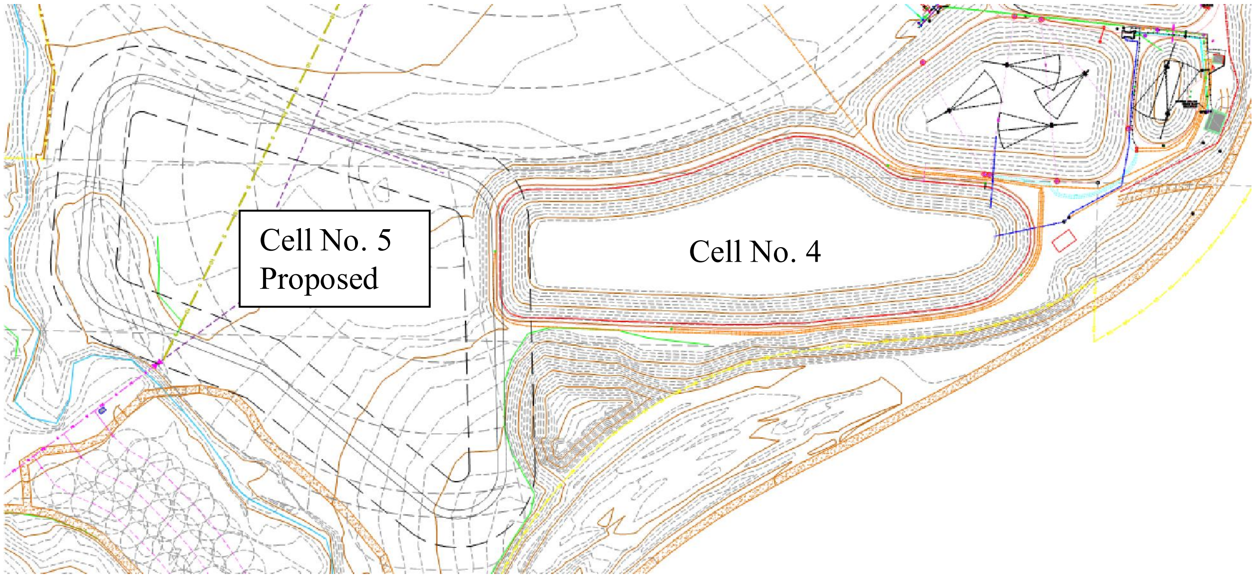


Figure 22 - Proposed Lagoon Cell No. 5 Location in Existing Field 2, S3

Proposed Lagoon Cell No. 5 has been shown in existing Field No. 2 just west of Lagoon Cell No. 4. This lagoon cell would eliminate Field No. 2. The lagoon size show is approximately 35 million gallons and would be similar to the total storage addition over the 20 year planning period. The western and southern boundary of the lagoon would be the Spirit Creek seasonal drainage channel. The north boundary would be the extent of the Field No. 1 center pivot operation. The eastern boundary would include Lagoon Cell No. 4 and the steep topography south of Lagoon Cell No. 4. This lagoon cell would be constructed at the same elevation as the existing lagoon cells to allow transfer via gravity.

4) Expand and deepen existing Lagoon Cell No. 2, S4

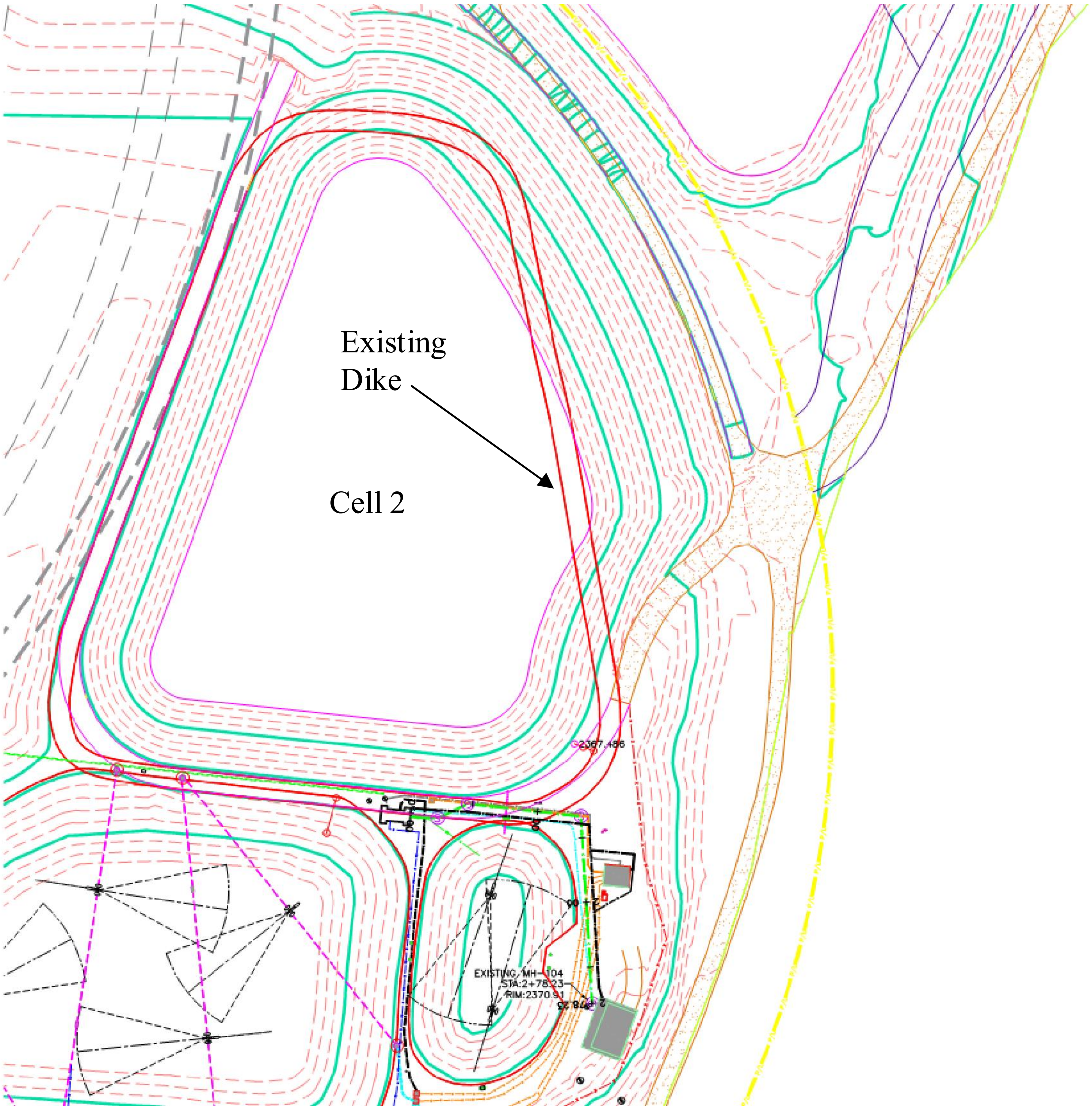


Figure 23 - Proposed Lagoon Cells No. 2-Expanded, S4

Figure 23 shows the outline of existing Lagoon Cell No. 2 overlain atop the proposed Lagoon Cell No. 2 expansion. In this expansion, Lagoon Cell No. 2 is deepened approximately 4-feet in depth and expanded to the northeast to meet the abandoned railroad embankment. The western boundary is Field No. 1 and the extent of Center Pivot No. 1 operation.

B) WASTEWATER TREATMENT

1) Expand the Chlorine Contact Piping System, T1

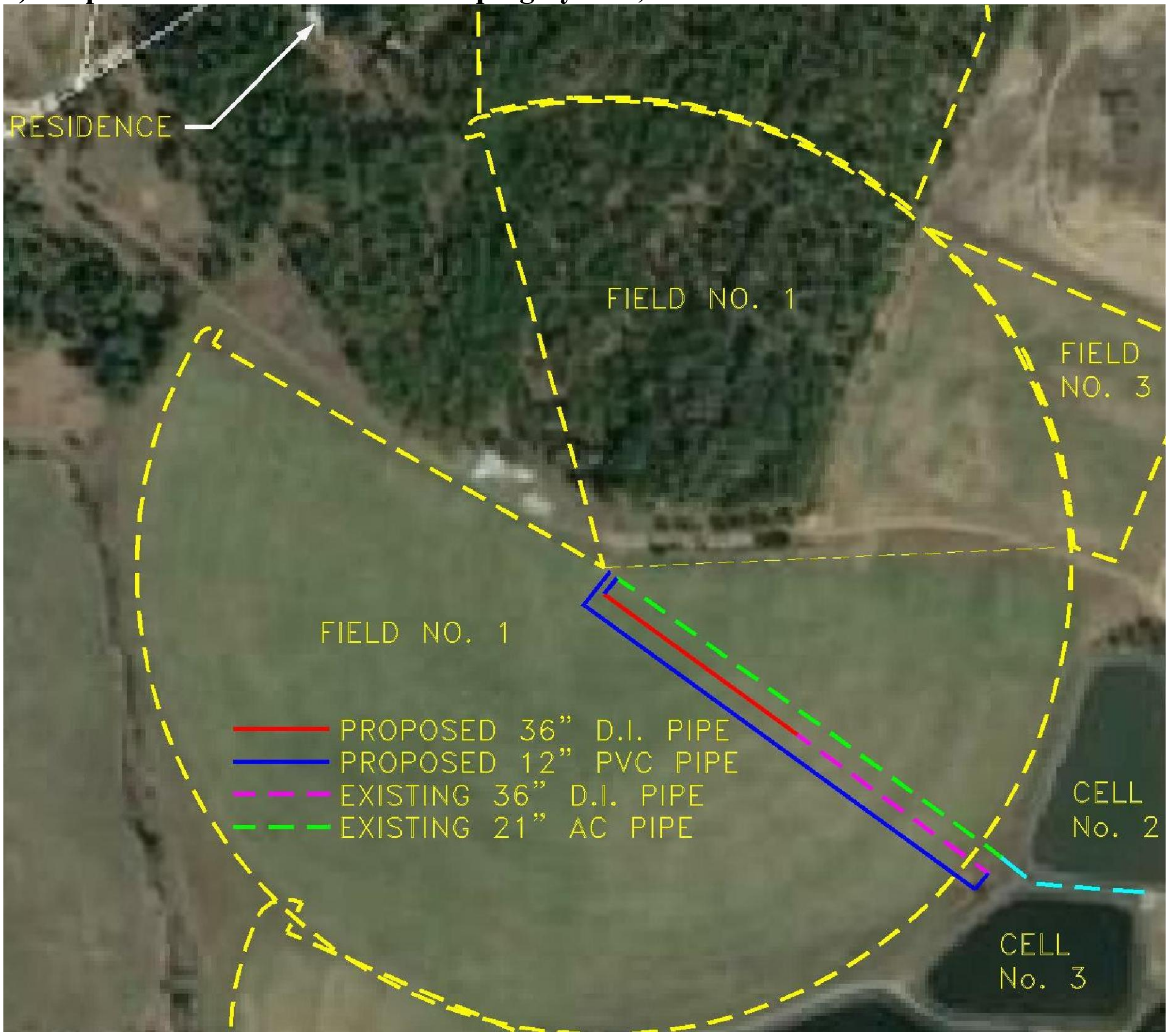


Figure 24 - Proposed Chlorine Contact Piping-Expanded, T1

Figure 24 shows the existing chlorine contact piping dashed in green and magenta. The proposed 36-inch piping addition is shown as a solid red line and the proposed 12-inch piping addition is shown as a solid blue line.

2) Install Aeration in Lagoon Cell No. 4, T2

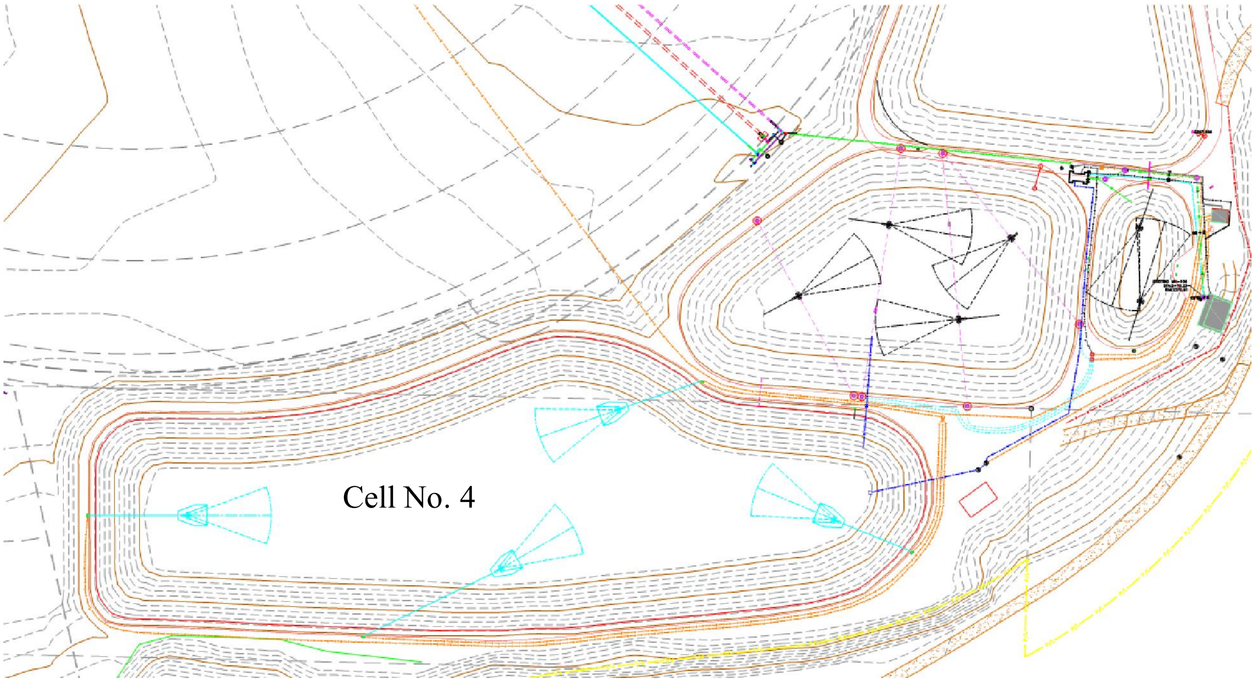


Figure 25 - Proposed Aerator Installation, Lagoon Cell No. 4, T2

Figure 25 shows the aerator locations for Lagoon Cell No. 4. The concrete erosion pads have previously been installed as well as the aerator mooring anchors. The electrical conduit is installed to each anchor location at the top of the lagoon dike. The electrical conduit has also previously been installed to the plant control building.

3) Install Aeration in Lagoon Cell No. 2, T3

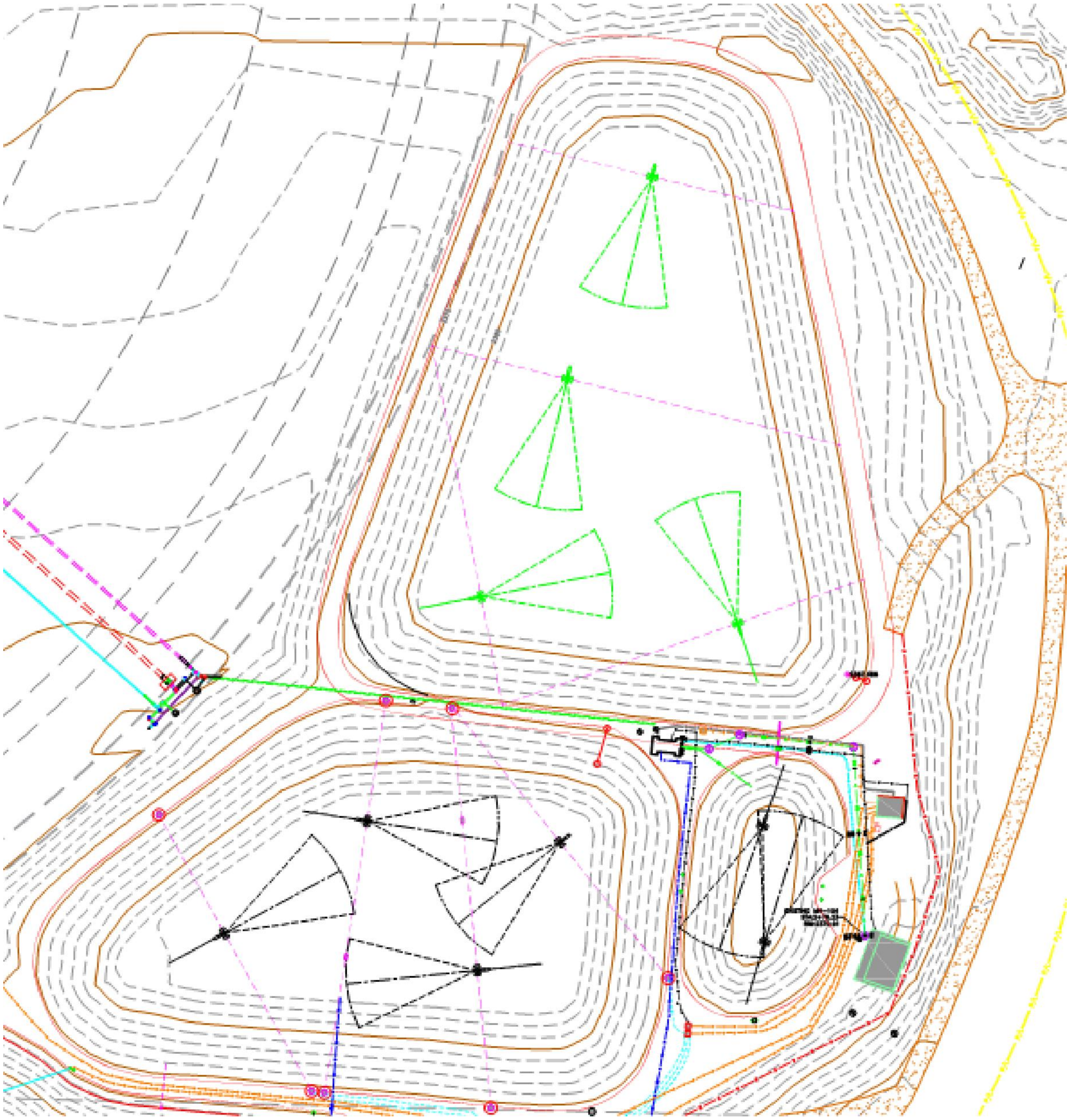


Figure 26 - Proposed Aerator Installation, Lagoon Cell No. 2, T3

Figure 26 identifies four 10 horsepower aerators positioned in Lagoon Cell No. 2 to mixing and aeration. This layout would include installation of the aeration equipment in this lagoon cell as it currently exists. It is proposed to deepen and expand Lagoon Cell No. 2 to add storage capacity.

4) Install Aeration in proposed Lagoon Cell No. 5, T4

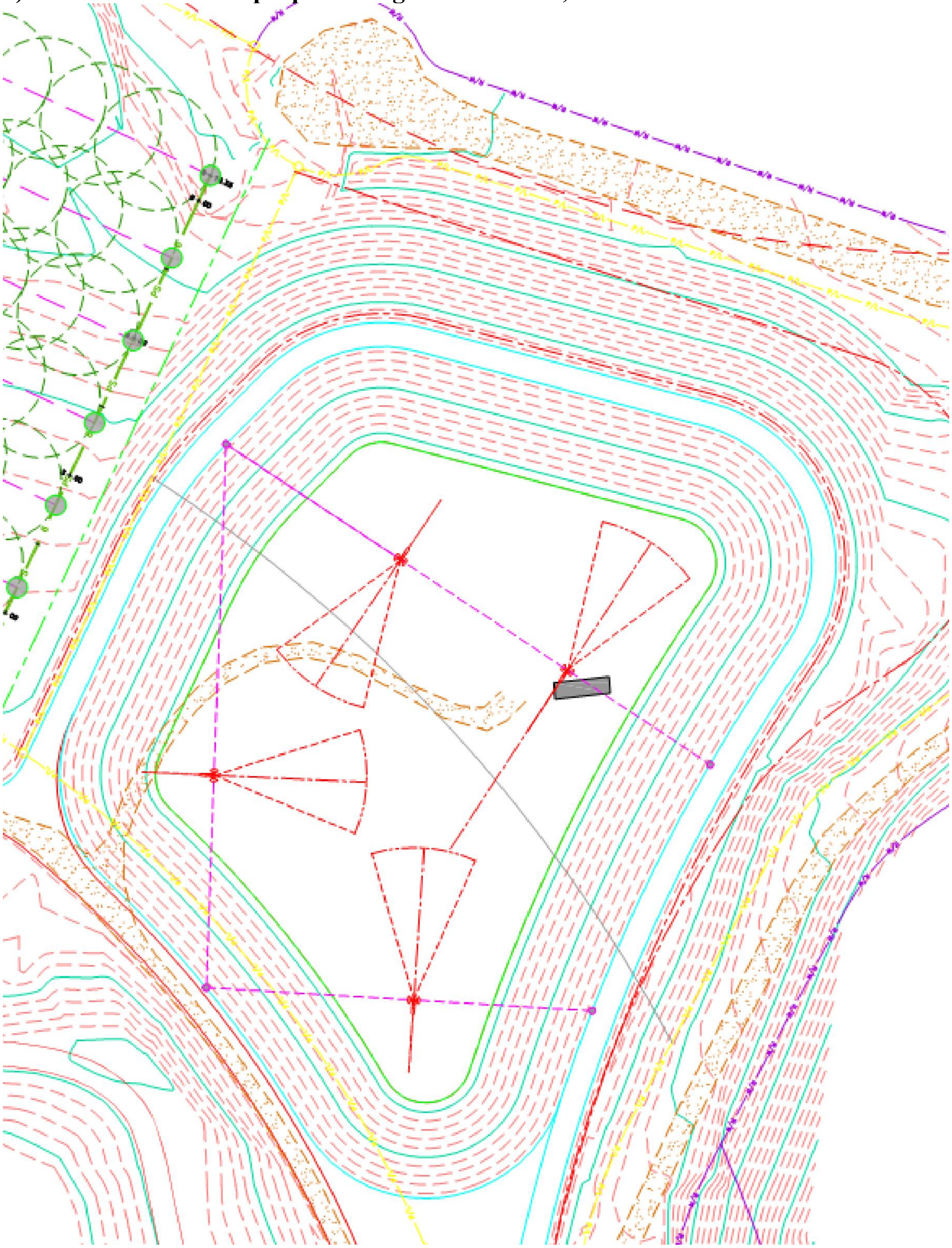


Figure 27 - Proposed Aerator Installation, Proposed Lagoon Cell No. 5, T4

Figure 27 shows the layout of four floating aspirating aerators installed in proposed Lagoon Cell No. 5.

C) LAND APPLICATION/REUSE SYSTEM

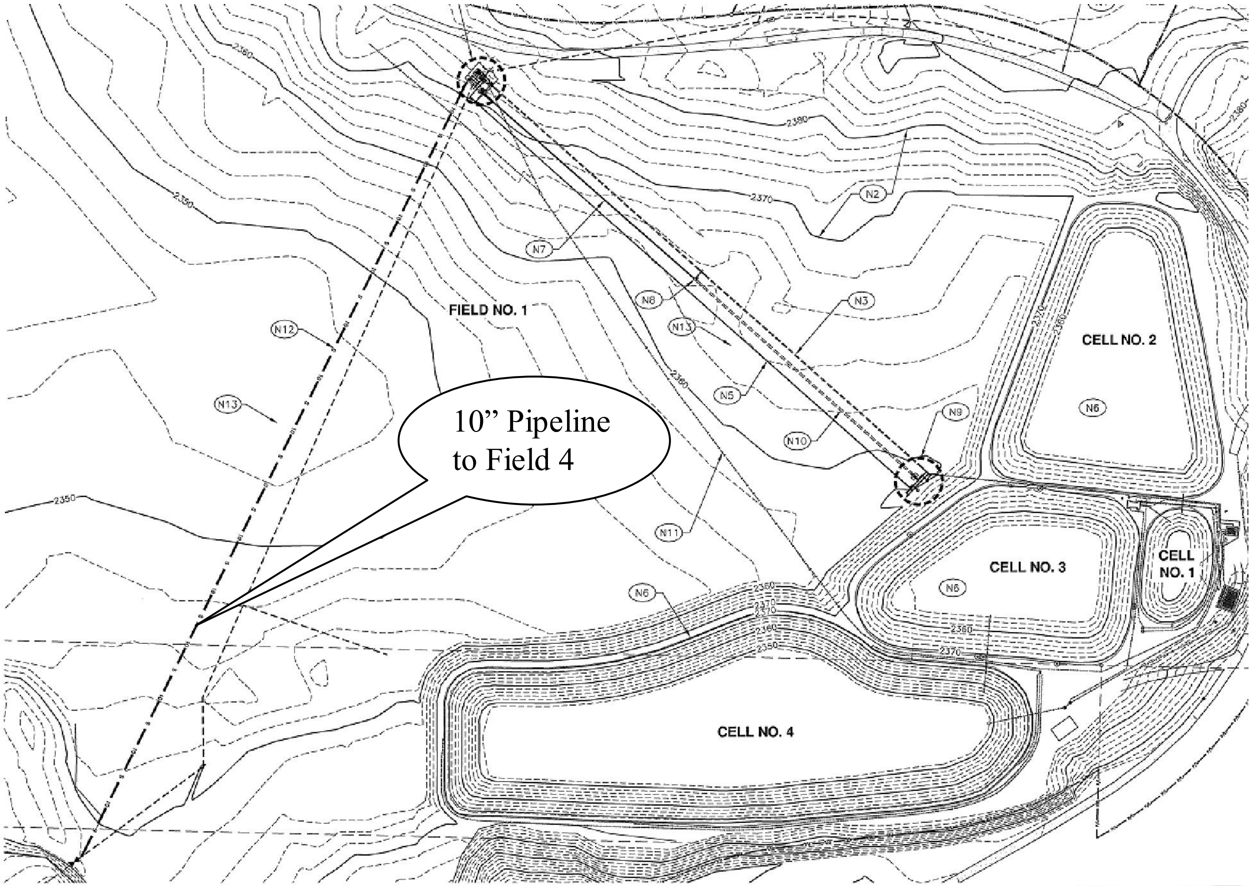


Figure 28 - Proposed Field No. 4 Transmission Pipeline

Figure 28 was taken from the bid package and construction drawings for installation of a 10-inch pipeline serving Field No. 4. The existing 6-inch line serving Field No. 2 and Field No. 4 is shown directly to the east of the proposed 10-inch pipeline. In this option the 6-inch line would remain and serve only Field No. 2 and the proposed 10-inch line would serve all of Field No. 4.

4. *Environmental Impacts*

A) LAGOON STORAGE

1) Construct a new Lagoon Cell No. 5 north of existing Lagoon Cell No. 2, S1

Construction of a new Lagoon Cell No. 5 north of the existing Lagoon Cell No. 2 would have minimal environmental impact. Several acres of the proposed site are listed as prime farmland; however, previous activity at the site has removed the topsoil and the site was formerly used as a borrow pit site. Therefore, the possibility of conducting agricultural activities on this site were previously eliminated.

This alternative does not impact wetlands, floodplains or important land resources. No known threatened or endangered species have been noted at the site and it is not a property of historic or known archaeological importance.

The southern portion of the site is lower in elevation and evidence of previous dumping of construction debris and trash is apparent. The proposed project will clean up and restore the site.

2) Construct two new lagoon cells north of existing Lagoon Cell no. 2, S2.

Construction of a two new lagoons of existing Lagoon Cell No. 2 would have minimal environmental impact. This alternative would have the same environmental consideration as the previous alternative.

3) Construct a new Lagoon Cell No. 5 on City property west of the current lagoon cells, S3

The environmental considerations for construction of a new lagoon cell west of the existing Lagoon Cell No. 4 in the area that is now currently Field No. 2 would impact several environmental aspects. A portion of Field No. 2 is noted as being on the border and partially in the Spirit Creek flood plain. The overlay of proposed Lagoon Cell No. 5 in Field No. 2 would encroach upon the currently mapped flood plain.

Field No. 2 is currently listed as prime farmland by USDA NRCS. Construction of a lagoon in this area would eliminate approximately 13 acres of prime farmland.

The proposed construction under this alternative would not affect wetlands, or threatened or endangered species. No known archaeological or historic properties are located within the proposed construction area.

4) Expand and deepen existing Lagoon Cell No. 2, S4

The environmental impacts associated with deepening and expanding Lagoon Cell No. 2 would be minimal. Lagoon Cell No. 2 is not located in a wetland or floodplain area. Construction of Lagoon Cell No. 2 previously eliminated the use of the land for agricultural purposes. The expansion to Lagoon Cell No. 2 is northeast of the lagoon cell and up against the abandoned railroad grade. Although listed as prime farm land, this area is not suitable for cultivation or agricultural activity due to its topography and shape.

The proposed construction would not affect threatened or endangered species and no known archaeological or historic sites are located within the proposed construction area. The expansion area was previously disturbed with construction of the railroad grade and prior construction of Lagoon Cell No. 2.

B) WASTEWATER TREATMENT

1) Expand the Chlorine Contact Piping System, T1

Expansion of the chlorine contact piping would include construction across a portion of Field No. 1. This area has previously been disturbed and construction would return the land in the same condition as pre-construction. There are no wetlands or floodplains in the area of the chlorine contact piping expansion. Field No. 1 is listed as prime farmland and is currently in cultivation as part of the City's land application system. Disruption would include excavation and trenching, pipe installation, backfill and site restoration. Installation of the pipeline would include salvage and separation of the topsoil during construction with backfill and replacement of the topsoil and reseeding of the established crop. Installation would occur following the growing/irrigation season. Field No. 1 does not include any listed archaeological or historic sites.

2) Install Aeration in Lagoon Cell No. 4, Cell No. 2 and Cell No. 5

Installation of aeration equipment in either Lagoon Cells No. 2, 4 or 5 would have minimal negative environmental impact. The aerators float on the pond surface and act to inject air/oxygen into the lagoons for treatment as well as mix the contents of the lagoon. The lagoons are not located in floodplains or wetland areas. They are not considered potential archaeological or historic sites. They are not prime farmland or habitat for threatened or endangered species.

C) LAND APPLICATION / REUSE SYSTEM

1) Install new piping manifold to Field No 4

Installation of an irrigation mainline to serve Field No. 4 would include construction across a portion of Field 1 and Field 2. This area has previously been disturbed and construction would return the land in the same condition as pre-construction. There are no wetlands or floodplains in the area of the Field 4 piping manifold. Field 1 and 2 are listed as prime farmland and are currently in cultivation as part of the City's land application system. Disruption would include excavation and trenching, pipe installation, backfill and site restoration. Installation of the pipeline would include salvage and separation of the topsoil during construction with backfill and replacement of the topsoil and reseeding of the established crop. Installation would occur following the growing/irrigation season. Field 1 and Field 2 do not include any listed archaeological or historic sites.

5. Land Requirements

The lands required for construction of previously described alternatives for lagoon storage expansion, wastewater treatment and land application/reuse system improvements are owned and controlled by the City of Spirit Lake. No lease agreements, easements or access agreements are required to construct the alternatives described herein.

6. Potential Construction Problems

Potential construction problems with each of the alternatives are described as follows:

A) LAGOON STORAGE

1) Construct a new Lagoon Cell No. 5 north of existing Lagoon Cell No. 2, S1

Several construction issues are associated with construction of a new lagoon cell in the newly acquired property located north and east of Lagoon Cell No. 2. There is evidence of previous dumping of construction debris near the low elevation of the property. The extent of construction debris has not been defined. Undoubtedly, there is a cost associated with separation and removal of the trash. If this alternative is selected a geotechnical investigation will be constructed to try and quantify the extent of the dumping area.

The second construction issue with this first alternative is the method of construction. Shaping and construction of the lagoon floor, dikes and walls will require that most of the excavated material be exported offsite to a stockpile location. This will required transport of the excavated material to a neighboring property for stockpile and final placement. The City is working with neighboring land owners to facilitate construction of a stockpile. Because of the topography and neighboring land uses, the option of balancing the cut/fill volumes will not be possible.

2) Construct two new lagoon cells north of existing Lagoon Cell No. 2, S2.

Construction issues associated with this alternative would look similar to the first alternative listed above.

3) Construct a new Lagoon Cell No. 5 on City property west of the current lagoon cells, S3.

The construction issues associated with building a new lagoon cell in the area that is currently Field 2 would include removal of the existing irrigation system and trying to operate the irrigation system with 13 less acres. Past operation of the land application system has proven that every acre is very valuable for irrigation purposes. Prior to removal of any acreage from the land application system, additional acreage would need to be added elsewhere. The City does not currently have an opportunity to replace this irrigation area.

4) Expand and deepen existing Lagoon Cell No. 2, S4.

There exists a significant amount of sludge in the base of Lagoon Cell No. 2. This would be required to be cleaned out as part of the deepening and expansion of Lagoon Cell No. 2. The second issue would be the timing of the construction. At the beginning of the construction season this lagoon cell is filled to the maximum water surface elevation along with the other three existing lagoon cells. In order for this lagoon cell to be ready for construction the City would need to irrigate all the wastewater within this lagoon cell and have the sludge dredged out of the lagoon cell. The time remaining in the construction season could be very limited after these activities are completed. The expansion of Lagoon Cell No. 2 would need to be completed by the end of September for property installation of the liner system and to allow the City to begin receiving and storing wastewater. Due to the constricted nature of the current storage situation, taking Lagoon Cell No. 2 out of the system for any length of time would be very challenging.

B) WASTEWATER TREATMENT

1) Expand the Chlorine Contact Piping System, T1

The potential construction issues associated with construction of the chlorine contact piping project include construction timing. The chlorine contact piping is utilized daily during the irrigation season. Construction of this alternative would be required to be done following the irrigation/land application season. Construction would be required to begin in October with completion in late November or early December. During this time of the year unfavorable weather could create construction challenges.

2) Install Aeration in Lagoon Cell No. 4, Lagoon Cell No. 2, or Lagoon Cell No. 5

Installation of the aeration equipment in either Lagoon Cell No. 4, 2 or 5 would require significant improvements to the plant electrical system and plant electrical service. The main potential construction issue with installation of additional aeration equipment includes operation of the existing treatment facility while reconstructing much of the plant electrical distribution system and motor control center.

C) LAND APPLICATION / REUSE SYSTEM

1) Install new piping manifold to Field No. 4

The potential construction issue associated with construction of a separate pipeline serving Field 4 would include the construction timing. The land application system is utilized daily during the irrigation/growing season. Construction of this alternative would be required to be done following the irrigation/land application season. Construction would be required to begin in October with completion in late November or early December. During this time of the year unfavorable weather could create construction challenges.

7. *Sustainability Considerations*

A) WATER AND ENERGY EFFICIENCY

1) Lagoon Storage Alternatives

Each of the lagoon storage alternatives will promote the City's continued commitment to wastewater land application and reuse. The lagoon storage alternatives provide additional treatment plant detention time which will result in better treatment prior to wastewater reuse. The City's wastewater treatment plant utilizes a natural system in which nutrients from the reuse water are applied to the crop. The crop provides the final step in the treatment process and every effort is made by the City to promote and grow a healthy crop. The City relies on the crop for treatment, and therefore sustaining the crop is the key to the treatment process.

Lagoon storage alternative 1, S1, includes construction of a new Lagoon Cell north of existing Lagoon Cell No. 2 on property the City recently purchased. This alternative is the most efficient in term of construction in that the greatest storage addition is realized for the cost and effort required for construction.

Lagoon storage alternative 2, S2, includes construction of two lagoon cells north of existing Lagoon Cell No. 2 on the property the City recently purchased. Alternative two will require roughly the same construction effort however; the storage addition is approximately 3.25 MG less than alternative 1.

Lagoon storage alternative 3, S3, includes construction of a lagoon cell west of Lagoon Cell No. 4 within the current Field 2. This alternative creates land application/reuse issues for the City in that it eliminates 13 acres of cropland which is part of the current land application system. Current operation of the land application system requires application to all the acres currently in the system and removal of 13 acres would require immediate replacement elsewhere which may be as bid a challenge as constructing a new lagoon.

Lagoon storage alternative 4, S4, includes deepening and expanding Lagoon Cell No. 2. This alternative would enable the City to correct several operational hurdles and increase the overall plant efficiency. First, deepening of the lagoon cell would allow for installation of aeration equipment. Second, this lagoon cell is in need of replacement of the current liner. Reconstruction would require installation of a new lagoon liner. Third, expansion of this cell would add approximately 5 million gallons in storage. Finally, reconstruction of Lagoon Cell No. 2 would require removal of the sludge blanket that exists in the bottom of the lagoon which will help in the treatment process.

2) Wastewater Treatment Alternatives

The alternatives considered for increasing the wastewater treatment plant performance are all intended to facilitate better treatment prior to reuse and land application.

Wastewater treatment alternative No. 1, T1, includes expansion of the chlorine contact piping system. The intent of this project is to allow the City to meeting disinfection permit limits easier. That would equate to less chlorine usage or the option of disinfection a larger volume of reuse water with the same amount of chlorine. This project is a treatment plant efficiency improvement.

Wastewater treatment alternative No. 2, T2, (Add aeration to Lagoon Cell No. 4), wastewater treatment alternative No. 3, T3, (Add aeration to Lagoon Cell No. 2), and wastewater treatment alternative No. 4, T4 (Add aeration to proposed Lagoon Cell No. 5) will all have the same energy impact on the system. Each of these options includes the addition of 40 horsepower in aeration capacity in each respective lagoon cell. The desired outcome of adding aeration to the treatment process is to enhance the biological treatment. In doing so, the reuse water at the end of the process will be cleaner (less organics and bacteria) prior to irrigation. This will result in less chlorine required for disinfection prior to irrigation. Each of the lagoon aeration alternatives will provide relatively the same improvement to the treatment process.

In terms of construction simplicity, wastewater treatment alternative No. 1, T1, (chlorine contact pipe) is the simplest to construct followed by alternative No. 2, T2, (Lagoon Cell No. 4 aeration). Installation of aeration in Lagoon Cell No. 2, T3, (alternative No. 3) should be completed after deepening and expansion of Lagoon Cell no. 2. Alternative No. 5, T4 (Lagoon Cell No. 5 Aeration), will require expansion of the electrical service and plant power distribution center.

3) Land Application/Reuse Alternatives

Land application alternative 1 includes extension of a separate supply pipeline installed to Field 4. This alternative will reduce irrigation pumping requirements and energy usage to supply reuse water to Field 4. It will also benefit the system in simplifying the irrigation system operation by having a dedicated supply line to Field 4. These are both improvements in plant operation and efficiency which result in a more sustainable system.

B) GREEN INFRASTRUCTURE

Each of the alternatives for wastewater lagoon storage, wastewater treatment, and land application reuse are intended to continue and enhance the natural treatment process. This process includes treatment of the incoming wastewater, storage of the wastewater over the winter, and application to the crops during the growing season. Application rates are set to match crop requirements for evapotranspiration. Field crops are harvested and utilized multiple times per year. Forest crops are harvested on a lengthier interval; however, harvested forest products are put to beneficial use. Following harvest, the process is started over and the crops are regrown for valuable use. In this way the entire treatment and reuse process is sustainable. The City relies heavily on the natural treatment process and operates the facility in a way to ensure that the crops are healthy and growing vigorously now and in years to come.

8. Cost Estimates

A) LAGOON STORAGE ALTERNATIVES

1) Alternative S1 – New Lagoon Cell Northeast of Lagoon Cell No. 2, S1

Table 16 - Alternative S1 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Mobilization	1	LS	$ 70,000.00	$ 70,000.00
2	Clearing & Grubbing	1	Acre	$ 5,000.00	$ 5,000.00
3	Mass Excavation	120,000	CY	$ 4.00	$ 480,000.00
4	Liner Bedding Sand	8,300	Ton	$ 6.02	$ 50,000.00
5	Lagoon Liner System	245,000	SF	$ 1.76	$ 430,000.00
6	Aerator Mooring & Anchor Assemblies	4	Ea.	$ 3,000.00	$ 12,000.00
7	Lagoon Dike Surfacing	400	Ton	$ 25.00	$ 10,000.00
8	Fencing	2,500	L.F.	$ 33.00	$ 82,500.00
9	Signage	10	Ea.	$ 250.00	$ 2,500.00
10	Inlet Piping	1,000	L.F.	$ 35.00	$ 35,000.00
11	Outlet Piping	200	L.F.	$ 35.00	$ 7,000.00
12	Concrete Structures	4	Ea.	$ 2,500.00	$ 10,000.00
13	Electrical Site Work	1	LS	$ 20,000.00	$ 20,000.00
14	Site Rehabilitation & Cleanup	1	LS	$ 15,000.00	$ 15,000.00
15	**Construction Cost Estimate**				**$ 1,229,000.00**

Table 17 - Alternative S1 – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Study & Report Phase	1	LS	$ 30,000.00	$ 30,000.00
2	Preliminary Design	1	LS	$ 30,000.00	$ 30,000.00
3	Final Design	1	LS	$ 52,500.00	$ 52,500.00
4	Bid Negotiating	1	LS	$ 10,000.00	$ 10,000.00

5	Construction Admin.	1	LS	$ 55,000.00	$ 55,000.00
6	Construction Inspection	1	LS	$ 52,500.00	$ 52,500.00
7	Project Closeout	1	LS	$ 20,000.00	$ 20,000.00
8	Legal Bond Council	1	LS	$ 26,500.00	$ 26,500.00
9	Interim Financing	1	LS	$ 35,000.00	$ 35,000.00
10	Construction Contingency	1	LS	$ 154,050.00	$ 154,050.00
11	**Non-Construction Cost Estimate**				**$ 465,550.00**

Table 18 - Alternative S1 – Project Cost Summary

Item	Description	Price
1	Construction Cost	$ 1,229,000.00
2	Non-Construction Cost	$ 465,550.00
3	DEQ Loan Retirement	$ 305,000.00
4	City Reserve Account Funding	($ 200,000.00)
5	**Loan Required**	**$ 1,799,550.00**

Table 19 - Alternative S1 – Operation & Maintenance Cost Estimate

Item	Description	Cost
1	Personnel	$ 128,281.00
2	Administrative Costs	$ 8,093.00
3	Waste Treatment Costs	$ 15,649.00
4	Insurance	$ 3,695.00
5	Energy Cost (Fuel and/or Electrical)	$ 26,070.00
6	Process Chemicals	$ 29,253.00
7	Monitoring & Testing	$ 7,374.00
8	Short Lived Asset Maintenance/Replacement	$ 45,636.00
9	Professional Services	$ 28,199.00
10	Residuals Disposal	$ 5,534.00
11	Miscellaneous	$ 2,285.00
12	Debt Service	$ 77,940.00
13	**Annual System Operation & Maintenance Costs**	**$ 378,009.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$ 27.61**

2) *Add Two Lagoon Cells Northeast of Lagoon Cell No. 2, S2*

Table 20 - Alternative S2 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Mobilization	1	LS	$ 70,000.00	$ 70,000.00
2	Clearing & Grubbing	1	Acre	$ 5,000.00	$ 5,000.00
3	Mass Excavation	98,000	CY	$ 4.00	$ 392,000.00
4	Liner Bedding Sand	7,100	Ton	$ 6.00	$ 42,600.00

5	Lagoon Liner System	190,000	SF	$ 1.76	$ 334,400.00
6	Aerator Mooring & Anchor Assemblies	4	Ea.	$ 3,000.00	$ 12,000.00
7	Lagoon Dike Surfacing	1,400	Ton	$ 25.00	$ 35,000.00
8	Fencing	2,500	L.F.	$ 33.00	$ 82,500.00
9	Signage	10	Ea.	$ 250.00	$ 2,500.00
10	Inlet Piping	1,400	L.F.	$ 35.00	$ 49,000.00
11	Outlet Piping	450	L.F.	$ 35.00	$ 15,750.00
12	Concrete Structures	11	Ea.	$ 2,500.00	$ 27,500.00
13	Electrical Site Work	1	LS	$ 35,000.00	$ 35,000.00
14	Site Rehabilitation & Cleanup	1	LS	$ 15,000.00	$ 15,000.00
15	**Construction Cost Estimate**				**$ 1,118,250.00**

Table 21 - Alternative S2 – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Study & Report Phase	1	LS	$ 30,000.00	$ 30,000.00
2	Preliminary Design	1	LS	$ 30,000.00	$ 30,000.00
3	Final Design	1	LS	$ 52,500.00	$ 52,500.00
4	Bid Negotiating	1	LS	$ 10,000.00	$ 10,000.00
5	Construction Admin.	1	LS	$ 55,000.00	$ 55,000.00
6	Construction Inspection	1	LS	$ 52,500.00	$ 52,500.00
7	Project Closeout	1	LS	$ 20,000.00	$ 20,000.00
8	Legal Bond Council	1	LS	$ 26,500.00	$ 26,500.00
9	Interim Financing	1	LS	$ 35,000.00	$ 35,000.00
10	Construction Contingency	1	LS	$ 142,975.00	$ 142,975.00
11	**Non-Construction Cost Estimate**				**$ 454,475.00**

Table 22 - Alternative S2 – Project Cost Summary

Item	Description	Price
1	Construction Cost	$ 1,118,250.00
2	Non-Construction Cost	$ 454,475.00
3	DEQ Loan Retirement	$ 305,000.00
4	City Reserve Account Funding	($ 200,000.00)
5	**Loan Required**	**$ 1,677,725.00**

Table 23 - Alternative S2 – Operation & Maintenance Cost Estimate

Item	Description	Cost
1	Personnel	$ 128,281.00
2	Administrative Costs	$ 8,093.00
3	Waste Treatment Costs	$ 15,649.00

4	Insurance	$	3,695.00
5	Energy Cost (Fuel and/or Electrical)	$	26,070.00
6	Process Chemicals	$	29,253.00
7	Monitoring & Testing	$	7,374.00
8	Short Lived Asset Maintenance/Replacement	$	45,636.00
9	Professional Services	$	28,199.00
10	Residuals Disposal	$	5,534.00
11	Miscellaneous	$	2,285.00
12	Debt Service	$	72,646.00
13	**Annual System Operation & Maintenance Costs**	**$**	**372,715.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$**	**27.22**

3) Add Lagoon Cell No. 5 West of Lagoon Cell No. 4, in Field 2, S3

Alternative 3 includes removal of Field 2 from the land application system. This would create an immediate problem for the City in terms of being able to irrigate the wastewater received at the plant. Therefore this alternative does not appear to be a technical feasible alternative, and a cost estimate has not been prepared.

4) Expand and Deepen Lagoon Cell No. 2, S4

Table 24 - Alternative S4 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Mobilization	1	LS	$ 60,000.00	$ 60,000.00
2	Sludge Removal	1	LS	$ 90,000.00	$ 90,000.00
3	Old Liner Removal	1	LS	$ 25,000.00	$ 25,000.00
4	Clearing and Grubbing	2	Acre	$ 5,000.00	$ 10,000.00
5	Mass Excavation	35,000	CY	$ 4.00	$ 140,000.00
6	Liner Bedding Sand	8,200	Ton	$ 6.00	$ 49,200.00
7	Lagoon Liner System	245,000	SF	$ 1.76	$ 428,750.00
8	Aerator Mooring & Anchor Assemblies	4	Ea.	$ 3,000.00	$ 12,000.00
9	Lagoon Dike Surfacing	600	Ton	$ 25.00	$ 15,000.00
10	Inlet Piping	1	L.S.	$ 25,000.00	$ 25,000.00
11	Outlet Piping	1	L.S.	$ 30,000.00	$ 30,000.00
12	Concrete Structures	4	Ea.	$ 2,500.00	$ 10,000.00
13	Electrical Site Work	1	L.S.	$ 15,000.00	$ 15,000.00
	Mid-Level Transfer Pipe	1	L.S.	$ 7,500.00	$ 7,500.00
14	Site Rehabilitation & Cleanup	1	LS	$ 10,000.00	$ 10,000.00
15	**Construction Cost Estimate**				**$ 927,450.00**

Table 25 - Alternative S4 – Non-Construction Cost Estimate					
Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Study & Report Phase	1	LS	$ 30,000.00	$ 30,000.00
2	Preliminary Design	1	LS	$ 30,000.00	$ 30,000.00
3	Final Design	1	LS	$ 52,500.00	$ 50,000.00
4	Bid Negotiating	1	LS	$ 10,000.00	$ 10,000.00
5	Construction Admin.	1	LS	$ 55,000.00	$ 50,000.00
6	Construction Inspection	1	LS	$ 52,500.00	$ 50,000.00
7	Project Closeout	1	LS	$ 20,000.00	$ 20,000.00
8	Legal Bond Council	1	LS	$ 26,500.00	$ 22,500.00
9	Interim Financing	1	LS	$ 35,000.00	$ 30,000.00
10	Construction Contingency	1	LS	$ 142,975.00	$ 121,995.00
11	**Non-Construction Cost Estimate**				**$ 414,495.00**

Table 26 - Alternative S4 – Project Cost Summary		
Item	Description	Price
1	Construction Cost	$ 927,450.00
2	Non-Construction Cost	$ 414,495.00
3	DEQ Loan Retirement	$ 305,000.00
4	City Reserve Account Funding	($ 200,000.00)
5	**Loan Required**	**$ 1,446,945.00**

Table 27 - Alternative S4 – Operation & Maintenance Cost Estimate		
Item	Description	Cost
1	Personnel	$ 128,281.00
2	Administrative Costs	$ 8,093.00
3	Waste Treatment Costs	$ 15,649.00
4	Insurance	$ 3,695.00
5	Energy Cost (Fuel and/or Electrical)	$ 26,070.00
6	Process Chemicals	$ 29,253.00
7	Monitoring & Testing	$ 7,374.00
8	Short Lived Asset Maintenance/Replacement	$ 45,636.00
9	Professional Services	$ 28,199.00
10	Residuals Disposal	$ 5,534.00
11	Miscellaneous	$ 2,285.00
12	Debt Service	$ 62,653.00
13	**Annual System Operation & Maintenance Costs**	**$ 362,722.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$ 26.49**

B) WASTEWATER TREATMENT ALTERNATIVES

1) Chlorine Contact Piping Expansion, T1

Table 28 - Alternative T1 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Mobilization	1	LS	$ 40,000.00	$ 40,000.00
2	36-in Pipe Installation	489	L.F.	$ 325.00	$ 158,925.00
3	12-in Pipe Installation	1,011	L.F.	$ 65.00	$ 65,715.00
4	Piping Interconnection, Pv1	1	L.S.	$ 60,000.00	$ 60,000.00
5	Interconnection, 3.1/7	1	L.S.	$ 55,000.00	$ 55,000.00
6	Interconnection, 4.1/8	1	L.S.	$ 20,000.00	$ 20,000.00
7	Fence Reconstruction	1	L.S.	$ 10,000.00	$ 10,000.00
8	Site Rehabilitation & Cleanup	1	LS	$ 28,000.00	$ 28,000.00
9	**Construction Cost Estimate**				**$ 437,640.00**

Table 29 - Alternative T1 – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Bid Negotiating	1	LS	$ 10,000.00	$ 10,000.00
2	Construction Admin.	1	LS	$ 26,000.00	$ 26,000.00
3	Construction Inspection	1	LS	$ 25,000.00	$ 25,000.00
4	Project Closeout	1	LS	$ 2,500.00	$ 2,500.00
5	Legal Bond Council	1	LS	$ 15,000.00	$ 15,000.00
6	Interim Financing	1	LS	$ 20,000.00	$ 20,000.00
7	Construction Contingency	1	LS	$ 45,000.00	$ 45,000.00
8	**Non-Construction Cost Estimate**				**$ 143,500.00**

Table 30 - Alternative T1 – Project Cost Summary

Item	Description	Price
1	Construction Cost	$ 437,640.00
2	Non-Construction Cost	$ 143,500.00
3	DEQ Loan Retirement	$ 305,000.00
4	City Reserve Account Funding	($ 200,000.00)
5	**Loan Required**	**$ 686,140.00**

Table 31 - Alternative T1 – Operation & Maintenance Cost Estimate

Item	Description	Cost
1	Personnel	$ 128,281.00
2	Administrative Costs	$ 8,093.00
3	Waste Treatment Costs	$ 15,649.00

4	Insurance	$	3,695.00
5	Energy Cost (Fuel and/or Electrical)	$	26,070.00
6	Process Chemicals	$	29,253.00
7	Monitoring & Testing	$	7,374.00
8	Short Lived Asset Maintenance/Replacement	$	45,636.00
9	Professional Services	$	28,199.00
10	Residuals Disposal	$	5,534.00
11	Miscellaneous	$	2,285.00
12	Debt Service	$	29,710.00
13	**Annual System Operation & Maintenance Costs**	**$**	**329,779.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$**	**24.09**

2) Install Aeration in Lagoon Cell No. 4, T2

Table 32 - Alternative T2 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price		Extended Amount	
1	Mobilization	1	LS	$	5,000.00	$	5,000.00
2	Aerator Installation	4	Ea.	$	5,000.00	$	20,000.00
3	Site Electrical	1	L.S	$	10,000.00	$	10,000.00
4	Plant MCC, Reconstruction	1	L.S.	$	35,000.00	$	35,000.00
5	Site Rehabilitation & Cleanup	1	LS	$	5,000.00	$	5,000.00
6	**Construction Cost Estimate**					**$**	**75,000.00**

Table 33 - Alternative T2 – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price		Extended Amount	
2	Preliminary Design	1	LS	$	2,500.00	$	2,500.00
3	Final Design	1	LS	$	7,500.00	$	7,500.00
4	Bid Negotiating	1	LS	$	5,000.00	$	5,000.00
5	Construction Admin.	1	LS	$	4,000.00	$	4,000.00
6	Construction Inspection	1	LS	$	4,000.00	$	4,000.00
7	Project Closeout	1	LS	$	2,000.00	$	2,000.00
8	Legal Bond Council	1	LS	$	5,000.00	$	5,000.00
9	Interim Financing	1	LS	$	4,500.00	$	4,500.00
10	Construction Contingency	1	LS	$	7,500.00	$	7,500.00
11	**Non-Construction Cost Estimate**					**$**	**42,000.00**

Table 34 - Alternative T2 – Project Cost Summary

Item	Description	Price

1	Construction Cost	$	75,000.00
2	Non-Construction Cost	$	42,000.00
3	DEQ Loan Retirement	$	305,000.00
4	City Reserve Account Funding	($	200,000.00)
5	**Loan Required**	**$**	**222,000.00**

Table 35 - Alternative T2 – Operation & Maintenance Cost Estimate

Item	Description	Cost	
1	Personnel	$	128,281.00
2	Administrative Costs	$	8,093.00
3	Waste Treatment Costs	$	15,649.00
4	Insurance	$	3,695.00
5	Energy Cost (Fuel and/or Electrical)	$	43,061.00
6	Process Chemicals	$	29,253.00
7	Monitoring & Testing	$	7,374.00
8	Short Lived Asset Maintenance/Replacement	$	45,636.00
9	Professional Services	$	28,199.00
10	Residuals Disposal	$	5,534.00
11	Miscellaneous	$	2,285.00
12	Debt Service	$	9,613.00
13	**Annual System Operation & Maintenance Costs**	**$**	**326,673.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$**	**23.86**

3) Install Aeration in Lagoon Cell No. 2, T3

Installation of aerators in Lagoon Cell No. 2 prior to reconstruction of the lagoon cell would require removal and replacement of the aerator anchoring system as well as removal and replacement of the site electrical serving the aerators. In addition, Lagoon Cell No. 2 is relatively shallow to accommodate full time operation of the aerators. Replacement of the existing lagoon liner is becoming a priority for the City, and reconstruction of the lagoon cell makes sense at the time of liner replacement. For these reasons, installation of aerators in Lagoon Cell No. 2 is not viewed as a technically feasible alternative at this time.

4) Install Aeration in Lagoon Cell No. 5, T4

Table 36 - Alternative T4 – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price		Extended Amount	
1	Mobilization	1	LS	$	9,000.00	$	9,000.00
2	Aerator Installation	4	Ea.	$	5,000.00	$	20,000.00
3	Site Electrical	1	L.S	$	15,000.00	$	15,000.00
4	Modify Plant Electrical Service	1	L.S.	$	25,000.00	$	25,000.00
5	Plant Electrical Building	200	S.F.	$	250.00	$	50,000.00

4	Plant MCC, Addition	1	L.S.	$ 40,000.00	$ 40,000.00
5	Site Rehabilitation & Cleanup	1	LS	$ 5,000.00	$ 5,000.00
6	**Construction Cost Estimate**				**$ 164,000.00**

Table 37 - Alternative T4 – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price	Extended Amount
1	Preliminary Design	1	LS	$ 2,500.00	$ 2,500.00
2	Final Design	1	LS	$ 12,500.00	$ 12,500.00
3	Bid Negotiating	1	LS	$ 5,000.00	$ 5,000.00
4	Construction Admin.	1	LS	$ 4,000.00	$ 4,000.00
5	Construction Inspection	1	LS	$ 4,000.00	$ 4,000.00
6	Project Closeout	1	LS	$ 3,000.00	$ 3,000.00
7	Legal Bond Council	1	LS	$ 10,000.00	$ 10,000.00
8	Interim Financing	1	LS	$ 10,000.00	$ 10,000.00
9	Construction Contingency	1	LS	$ 16,500.00	$ 16,500.00
10	**Non-Construction Cost Estimate**				**$ 67,500.00**

Table 38 - Alternative T4 – Project Cost Summary

Item	Description	Price
1	Construction Cost	$ 67,500.00
2	Non-Construction Cost	$ 164,000.00
3	DEQ Loan Retirement	$ 305,000.00
4	City Reserve Account Funding	($ 200,000.00)
5	**Loan Required**	**$ 336,500.00**

Table 39 - Alternative T4 – Operation & Maintenance Cost Estimate

Item	Description	Cost
1	Personnel	$ 128,281.00
2	Administrative Costs	$ 8,093.00
3	Waste Treatment Costs	$ 15,649.00
4	Insurance	$ 3,695.00
5	Energy Cost (Fuel and/or Electrical)	$ 43,061.00
6	Process Chemicals	$ 29,253.00
7	Monitoring & Testing	$ 7,374.00
8	Short Lived Asset Maintenance/Replacement	$ 45,636.00
9	Professional Services	$ 28,199.00
10	Residuals Disposal	$ 5,534.00
11	Miscellaneous	$ 2,285.00
12	Debt Service	$ 14,570.00

13	**Annual System Operation & Maintenance Costs**	**$**	**331,630.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$**	**24.22**

C) LAND APPLICATION/REUSE SYSTEM ALTERNATIVES

1) Field 4 Manifold Piping

Table 40 - Field 4 Manifold Piping – Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price		Extended Amount	
1	Mobilization	1	LS	$	7,000.00	$	7,000.00
2	10-inch PVC Piping	1,500	L.F.	$	56.00	$	84,000.00
3	Piping Interconnection	1	L.S	$	15,000.00	$	15,000.00
4	Site Rehabilitation & Cleanup	1	LS	$	5,000.00	$	5,000.00
5	**Construction Cost Estimate**					**$**	**111,000.00**

Table 41 - Field 4 Manifold Piping – Non-Construction Cost Estimate

Item	Description	Quantity	Unit	Unit Price		Extended Amount	
1	Bid Negotiating	1	LS	$	5,000.00	$	5,000.00
2	Construction Admin.	1	LS	$	5,500.00	$	5,500.00
3	Construction Inspection	1	LS	$	5,500.00	$	5,500.00
4	Project Closeout	1	LS	$	2,000.00	$	2,000.00
5	Legal Bond Council	1	LS	$	10,000.00	$	10,000.00
6	Interim Financing	1	LS	$	6,000.00	$	6,000.00
7	Construction Contingency	1	LS	$	11,000.00	$	11,000.00
8	**Non-Construction Cost Estimate**					**$**	**45,000.00**

Table 42 - Field 4 Manifold Piping – Project Cost Summary

Item	Description	Price	
1	Construction Cost	$	111,000.00
2	Non-Construction Cost	$	45,000.00
3	DEQ Loan Retirement	$	305,000.00
4	City Reserve Account Funding	($	200,000.00)
5	**Loan Required**	**$**	**261,000.00**

Table 43 - Field 4 Manifold Piping – Operation & Maintenance Cost Estimate

Item	Description	Cost	
1	Personnel	$	128,281.00
2	Administrative Costs	$	8,093.00

3	Waste Treatment Costs	$	15,649.00
4	Insurance	$	3,695.00
5	Energy Cost (Fuel and/or Electrical)	$	26,070.00
6	Process Chemicals	$	29,253.00
7	Monitoring & Testing	$	7,374.00
8	Short Lived Asset Maintenance/Replacement	$	45,636.00
9	Professional Services	$	28,199.00
10	Residuals Disposal	$	5,534.00
11	Miscellaneous	$	2,285.00
12	Debt Service	$	11,301.00
13	**Annual System Operation & Maintenance Costs**	**$**	**311,370.00**
14	**Monthly O&M Fee @ 1,141 ERUs**	**$**	**22.74**

F. Alternatives Analysis

1. Life Cycle Cost Analysis

The life cycle cost analysis addresses the present worth of the life cycle costs for each of the alternatives considered. For collection and distribution projects, a planning period of 40 years is recommended in the Idaho Interagency Facility Plan Memorandum. For wastewater treatment projects a planning period of 20 years is recommended in the same document. A discount rate is utilized to calculate future benefits and costs associated with a given project. Discounting allows future costs to be converted to a common time basis for comparison. The discount rate utilize is defined by EPA for 2017 under 40CFR35.2030(b)(3), 18CFR704.39 is 3%.

The increase shown for Operation and Maintenance expenses represents the anticipated O&M cost increase between those realized in fiscal year 2017 and the proposed alternative.

The short lived asset costs represents the value of mechanical equipment that are anticipated to be at their useful life within the 20 year planning period and will be in need of replacement.

A) LAGOON STORAGE ALTERNATIVES – PRESENT WORTH ANALYSIS

1) Construct a new lagoon northeast of Lagoon Cell No. 2, S1

Table 44 - Lagoon Storage Alternative S1 – New Lagoon Cell No. 5
20 Year Life Span at 3% Discount Rate

Description	Install New Lagoon Northeast of Existing Cell No. 2 (Alternative No. S1)	Adjusted Present Value
Initial Construction Cost	$ 1,229,000	$ 1,229,000
Non-Construction Costs	$ 465,550	$ 465,550
Additional Annual O&M Costs	$ 33,281	$ 495,121
Salvage Value	$ 0	$ 0
Net Present Value		**$ 2,189,671**
Short Lived Asset Cost	**$ 0.00**	

Cost / Benefit = $ 2,189,671 to add 17 MG of storage or $ 128,804 per MG

2) Construct two new lagoon cells northeast of Lagoon Cell No. 2, S2

Table 45 - Lagoon Storage Alternative S2 – Two New Lagoon Cells
20 Year Life Span at 3% Discount Rate

Description	Install Two Lagoons Northeast of Existing Cell No. 2 (Alternative No. S2)	Adjusted Present Value
Initial Construction Cost	$ 1,118,250	$ 1,118,250
Non-Construction Costs	$ 454,475	$ 454,475
Additional Annual O&M Costs	$ 27,987	$ 416,363
Salvage Value	$ 0	$ 0
Net Present Value		**$ 1,989,088**
Short Lived Asset Cost	**$ 0.00**	

Cost / Benefit = $ 1,989,088 to add 13.7 MG of storage or $ 145,189 per MG

3) Expand and deepen Lagoon Cell No. 2, S4

Table 46 - Lagoon Storage Alternative S4 – Expand Lagoon Cell No. 2
20 Year Life Span at 3% Discount Rate

Description	Install Two Lagoons Northeast of Existing Cell No. 2 (Alternative No. S4)	Adjusted Present Value
Initial Construction Cost	$ 927,450	$ 927,450
Non-Construction Costs	$ 414,495	$ 414,495

Additional Annual O&M Costs	$ 17,994	$ 267,697
Salvage Value	$ 0	$ 0
Net Present Value		**$ 1,609,642**
Short Lived Asset Cost	**$ 0.00**	

Cost / Benefit = $ 1,609,642 to add 5.0 MG of storage or $ 321,928 per MG

B) Wastewater Treatment Alternatives – Present Worth Analysis

1) Expand Chlorine Contact Piping System, T1

Table 47 - Treatment Alternative T1 – Expand Chlorine Contact Pipe
20 Year Life Span at 3% Discount Rate

Description	**Extend Chlorine Contact Pipe (Alternative No. T1)**	**Adjusted Present Value**
Initial Construction Cost	$ 437,640	$ 437,640
Non-Construction Costs	$ 143,500	$ 143,500
Additional Annual O&M Costs	$ 19,708	$ 293,196
Salvage Value	$ 0	$ 0
Net Present Value		**$ 874,336**
Short Lived Asset Cost	**$ 0.00**	

2) Install Aeration in Lagoon Cell No. 4, T2

Table 48 - Treatment Alternative T2 – Install Aeration in Lagoon Cell No. 4
20 Year Life Span at 3% Discount Rate

Description	**Install Aeration in Lagoon Cell No. 4 (Alternative No. T2)**	**Adjusted Present Value**
Initial Construction Cost	$ 75,000	$ 75,000
Non-Construction Costs	$ 42,000	$ 42,000
Additional Annual O&M Costs	$ 36,698	$ 545,956
Salvage Value	($ 2,000)	($ 1,107)
Net Present Value		**$ 661,849**
Short Lived Asset Cost	**$ 60,000**	

3) Install Aeration in Lagoon Cell No. 5, T4

Table 49 - Treatment Alternative T4 – Install Aeration in Lagoon Cell No. 5
20 Year Life Span at 3% Discount Rate

Description	**Install Aeration in Lagoon**	**Adjusted Present Value**

	Cell No. 5 (Alternative No. T4)	
Initial Construction Cost	$ 164,000	$ 164,000
Non-Construction Costs	$ 67,500	$ 67,500
Additional Annual O&M Costs	$ 50,272	$ 749,384
Salvage Value	($ 2,000)	($ 1,107)
Net Present Value		**$ 979,777**
Short Lived Asset Cost	**$ 60,000**	

C) LAND APPLICATION / REUSE SYSTEM – PRESENT WORTH ANALYSIS

1) Install new piping manifold to Field 4

Table 50 - Reuse Alternative – Install Manifold Pipe to Field No. 5
20 Year Life Span at 3% Discount Rate

Description	**Install New Manifold Pipe to Field No. 5**	**Adjusted Present Value**
Initial Construction Cost	$ 111,000	$ 111,000
Non-Construction Costs	$ 45,000	$ 45,000
Additional Annual O&M Costs	$ 19,708	$ 293,196
Salvage Value	$ 0	$ 0
Net Present Value		**$ 449,196**
Short Lived Asset Cost	**$ 0**	

According to the previous present worth tables the most cost effective alternatives are:

Wastewater Storage Alternative – New Lagoon Cell No. 5, S1

Wastewater Treatment Alternative – Install Aeration In Lagoon Cell No. 4

2. *Non-Monetary Factors*

A decisions matrix was used to assist in the process of recommending an alternative for final design. A decision matrix is a list of values in rows and columns that enable the user to systematically identify, analyze, and rate the performance of relationships between sets of values and information. Elements of a decision matrix show evaluation factors based on certain decision criteria. The matrix is useful for looking at competing decision factors and assessing each factor's relative significance.

The matrix allows the user to weight the factors relative to their importance. The matrix is useful where quantitative analysis indicates two or more alternatives are close in importance.

For this project, we have included evaluation factors which are often considered qualitative such as complexity, ease of operation, as well as other factors which were included in the economic analysis. These factors have been given weights based on what we feel, in our experience, are important. A score was assigned to each of the factors for each of the alternatives to indicate how well the alternative addressed the issue. The scores had a possible range of 1 to 5, with a low score indicating a more favorable alternative. A total score for each alternative was obtained by multiplying the individual scores by the weight factors and summing the results. Table 51 and Table 52 below present the evaluation matrix for the viable alternatives.

Table 51 - Decision Matrix – Wastewater Storage Addition

	Storage Addition	Installation Difficulty	Capital Cost	Present Value Cost	Operational Cost	System Complexity	Ease of Operation	Treatment Challenges	Future Compliance Risk	**Total Weighted Score**
Weight Factor	50	30	30	10	30	30	20	30	50	
New Lagoon Cell No. 5, **S1**	1	3	4	4	3	2	2	3	2	**680**
Two New Lagoon Cells, **S2**	3	2	3	3	4	4	4	4	3	**920**
Expand Lagoon Cell No. 2, **S4**	5	5	2	2	2	1	1	2	1	**700**

Notes:

1. A high score indicates more negative factors
2. A low score indicates a more favorable alternative

Table 52 - Decision Matrix – Wastewater Treatment Alternatives

	Installation Difficulty	Capital Cost	Present Value Cost	Operational Costs	Ease of Operation	Longevity	Future Compliance Risk	Treatment Challenges	Ease of Repair	**Total Weighted Value**
Weight Factor	30	40	20	30	20	40	50	40	30	
Chlorine Contact Pipe, **T1**	3	3	2	1	1	1	2	2	5	**670**
Aeration in Cell No. 4, **T2**	1	1	1	4	3	4	3	3	1	**730**
Aeration in Cell No. 5, **T4**	5	2	3	4	3	4	4	4	2	**1,050**

Notes:
1. A high score indicates more negative factors
2. A low score indicates a more favorable alternative

G. Proposed Project (Recommended Alternative)

A number of the alternatives reviewed would create significant beneficial improvements to the wastewater treatment facility. The item of greatest concern currently is the lagoon storage addition. The recommended plan for proceeding with improvements at the wastewater treatment plant is outlined in order of priority as follows:

1. Install Lagoon Cell No. 5 as outlined under alternative, S1
2. Install Aeration in Lagoon Cell No. 4 as outlined under alternative, T2
3. Install Chlorine Contact Improvement as outlined under alternative, T1
4. Install Manifold to Field 4 as outlined under the land application alternative
5. Deepen and Expand Lagoon Cell No. 2 as outlined under alternative, S4
6. Install Aeration in Lagoon Cell No. 2 as outlined under alternative, T3
7. Install Aeration in Lagoon Cell No. 5 as outlined under alternative, T4

It is also recommended to continue with long term plans to acquire additional properties to expand the wastewater land application system in the future. By the year 2025 the land application system will once again be at capacity assuming a controlled 4% growth rate. The installation of Lagoon Cell No. 5 will provide storage capacity up to approximately 1,595 ERUs or approximately the year 2028 at the assumed growth of 4%.

1) Preliminary Project Design

The initial design for the addition of Lagoon Cell No. 5 as outlined in alternative S1 includes construction of the lagoon on newly acquired property just north and east of the existing Lagoon Cell No. 2. This area was previously a shooting range and prior to that a borrow pit. The proposed lagoon cell would be constructed roughly 21 feet in total depth with a maximum water surface of 18-feet above the lagoon floor. The base elevation would be constructed at 2368.00 and the top elevation 2389.00. A dike road surrounding the top of the lagoon cell would be constructed at the 2389.00 elevation. The north, east and west sides of the lagoons would include a ditch between the dike road and the upslope in order to gather runoff proceeding down the hill and direct it around the lagoon cell.

The lagoon cell would be constructed with a bottom sloping to the southernmost corner. The sloping floor will serve two main purposes. The first is to determine if a leak is evident in the lagoon lining system. The lagoon lining system is proposed with two layers of 60 mil HDPE liner. The layers will be separated with a layer of geonet fabric which is designed to allow fluid to flow through the interstitial space between the liners. A leak in the primary liner would allow water into the interstitial space which would collect at the low point in the lagoon cell. An outlet pipe would be installed at the low point and would extend from the interstitial space between the liner layers to an inspection/sampling manhole. Routine visual observation of the inspection manhole would allow the detection of water, indicating a leak in the primary liner layer.

The second reason for sloping the bottom of the lagoon cell is to allow for drainage of the entire contents of the lagoon in the event that liner maintenance or repairs are necessary.

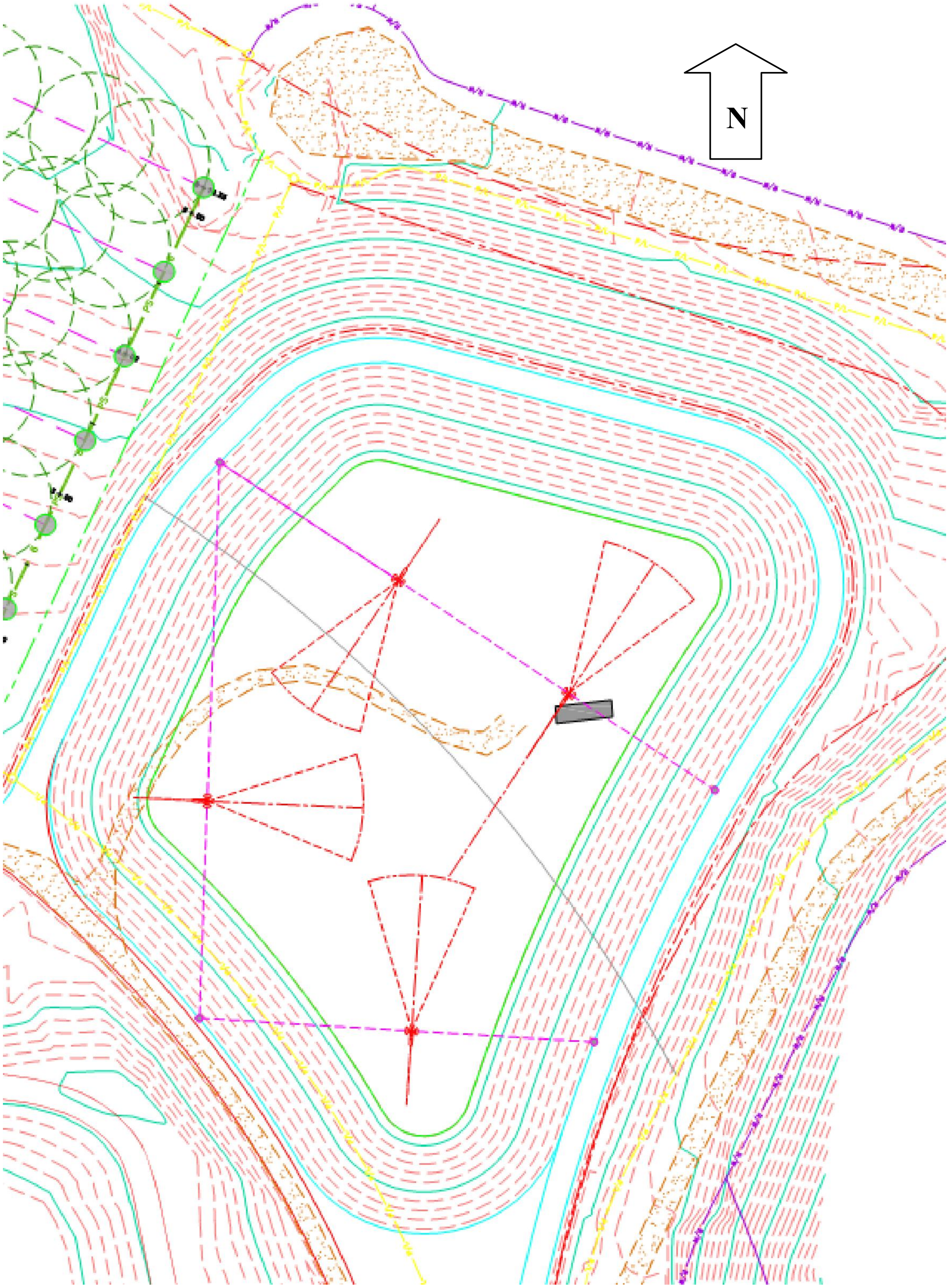


Figure 29 - Proposed Lagoon Cell No. 5

The lagoon cell would be constructed to allow easy installation of aeration equipment in the future. This would include installation of aeration mooring anchors at strategic locations around the lagoon dike and installation of electrical conduits within the lagoon dikes to serve the future aerators.

Wastewater would be transferred to the lagoon cell via the irrigation pump station. A dedicated line would be installed along the west side of Lagoon Cell No. 2. This line would connect into the distribution piping that branches and serves Lagoon Cell No. 4 and the chlorine contact system. The route along the west side of Lagoon Cell No. 2 would be located at the toe of the existing dike which is on the east side of the service road around existing Field No. 1. The pipeline would outlet into the southwest corner of proposed Lagoon Cell No. 5. A transfer pipe would be installed between the proposed Lagoon Cell No. 5 and existing Lagoon Cell No. 2 to allow wastewater to gravity flow back from Cell No. 5 to Cell No. 2.

The proposed Lagoon Cell No. 5 volume is approximately 17 million gallons. This volume in addition with the existing storage cells in the system would provide storage capacity for approximately 1,595 ERUs. Normal operation would include winter storage over the non-growing season. Treated wastewater would be pumped into Lagoon Cell No. 5 after it has passed through existing Lagoon Cells No. 1, No. 2, No. 3 and No. 4. Proposed Lagoon Cell No. 5 would be filled prior to the start of the irrigation season in May. In doing so, the irrigation pumps would not be required to transfer wastewater into Lagoon Cell No. 5 during the irrigation period. The contents of Lagoon Cell No. 5 would be allowed to gravity flow back into existing Lagoon Cell No. 2 and then be irrigated with the normal process.

A groundwater monitoring networks will be installed by installing three groundwater monitoring wells into aquifer. One of these wells will be located up-gradient near the west border of Field 1 with Spirit Creek. One well would be located down-gradient new the northeast corner of proposed Lagoon Cell No. 5 and the third well will be located in the northwest corner of Field No. 5. The latter two wells are considered downgradient from the treatment facility if groundwater flow is from Southwest to Northeast. The complete groundwater monitoring plan has been attached in Appendix D-2.

2) Project Implementation Schedule

The need for proposed Lagoon Cell No. 5 is urgent and therefore a very direct schedule for construction of proposed Lagoon Cell No. 5 is presented as follows:

Table 53 - Project Timeline – Lagoon Cell No. 5 Construction

Task	Anticipated Completion Date
Land Acquisition	Completed
Wastewater Facility Plan Submittal to DEQ & USDA RD	January, 2018
Facility Plan Approval	February, 2018
Construction Plan Submittal for Approval	April, 2018
Bond Election	May, 2018
Advertisement for Bid	May, 2018
Bid Opening	June, 2018
Bid Award	June, 2018
Construction Notice to Proceed Issued	July, 2018

Construction Substantial Completion	October, 2018
Construction Final Completion	November, 2018
Project Closeout	December, 2018
Initiation of Operation by City	November, 2018
Loan Closeout	January, 2019
First Payment Due	January, 2020

3) Permit Requirements

The City holds a permit for operation of their wastewater treatment plant. The permit is administered by the Idaho Department of Environmental Quality (IDEQ). The permit is renewed on a 10 year cycle. Major modifications to the facility require review and issuance of a permit modification by IDEQ. The City's current reuse permit was last modified on June 30, 2017 under permit number M-002-05 Modification 1.

A conditional use permit is required by Bonner County for operation of the wastewater treatment facility. As part of the plant expansion the conditional use process will be revisited to determine if the addition of proposed Lagoon Cell No. 5 will require modification to the existing conditional use permit and approval by Bonner County.

The proposed project will not require a building permit.

4) Sustainability Considerations

A) WATER AND ENERGY EFFICIENCY

The City's wastewater treatment process is a reuse system which utilizes the treated wastewater for beneficial use through crop uptake and nutrient removal. Construction of proposed Lagoon Cell No. 5 will provide the City with the capacity to provide longer detention times in the treatment process resulting in higher quality effluent applied to the reuse sites. The higher quality effluent requires less chlorine for disinfection purposes prior to land application. The installation of proposed Lagoon Cell No. 5 will help to reduce the total chlorine usage at the plant.

Proposed Lagoon Cell No. 5 presents an energy efficient design in that it can be filled during the non-irrigation season with treated wastewater at a slower rate and then returned without pumping, via gravity, for irrigation at much higher irrigation rates.

B) GREEN INFRASTRUCTURE

The proposed Lagoon Cell No. 5 will collect and manage stormwater through the natural reuse process. Stormwater that enters the proposed Lagoon Cell No. 5 with be treated and then irrigated to the reuse crop over the growing season. The crop is comprised of natural plants that need water and nutrients to maintain and thrive. The water and nutrients present in the irrigation water is set to match the plant requirements over the growing season. The City manages this by determining the daily irrigation rates based on current weather conditions and documented crop needs. The installation of proposed Lagoon Cell No. 5 will continue to facilitate the City's natural wastewater treatment system.

C) GREEN PROJECT RESERVE (GPR)

The Green Project Reserve analysis has not been completed for proposed Lagoon Cell No. 5

D) OTHER

The City's current wastewater treatment process is considered very straight forward and relatively simple in terms of treatment and mechanical complexity. It does not require extensive operator training. The system can generally be managed by a single operator. It does not contain an abundance of mechanical equipment to complete the process. Generally, these types of wastewater treatment systems are sustainable, resilient and provide the operator the opportunity to complete the necessary treatment in the event of power outages or common system issues. The City's treatment process is a natural biological process. Proposed Lagoon Cell No. 5 is consistent with the existing plant and will continue using the same system process currently utilized by the City.

5) Operator Requirements

The proposed project will not require additional plant operators or require additional license classes. The current wastewater treatment plant classification based on the current reuse permit is Classification II. The IDEQ *Idaho Public Wastewater Treatment Plant Classification Worksheet* has been completed and indicates a Classification I operator license would be required for the plant. The addition of proposed Lagoon Cell No. 5 will not add additional processes or equipment to the existing system.

6) Total Project Cost Estimate

Table 54 - Cost Estimate – Lagoon Cell No. 5 – S1

Item	Description	Quantity	Unit	Unit Price	Extended Amount
Construction					
1	Mobilization	1	LS	$ 70,000.00	$ 70,000.00
2	Clearing & Grubbing	1	Acre	$ 5,000.00	$ 5,000.00
3	Mass Excavation	120,000	CY	$ 4.00	$ 480,000.00
4	Liner Bedding Sand	8,300	Ton	$ 6.02	$ 50,000.00
5	Lagoon Liner System	245,000	SF	$ 1.76	$ 430,000.00
6	Aerator Mooring & Anchor Assemblies	4	Ea.	$ 3,000.00	$ 12,000.00
7	Lagoon Dike Surfacing	400	Ton	$ 25.00	$ 10,000.00
8	Fencing	2,500	L.F.	$ 33.00	$ 82,500.00
9	Signage	10	Ea.	$ 250.00	$ 2,500.00
10	Inlet Piping	1,000	L.F.	$ 35.00	$ 35,000.00
11	Outlet Piping	200	L.F.	$ 35.00	$ 7,000.00
12	Concrete Structures	4	Ea.	$ 2,500.00	$ 10,000.00
13	Electrical Site Work	1	LS	$ 20,000.00	$ 20,000.00

14	Site Rehabilitation & Cleanup	1	LS	$ 15,000.00	$ 15,000.00
15	**Construction Cost Estimate**				**$ 1,229,000.00**
Non-Construction					
16	Study & Report Phase	1	LS	$ 30,000.00	$ 30,000.00
17	Preliminary Design	1	LS	$ 30,000.00	$ 30,000.00
18	Final Design	1	LS	$ 52,500.00	$ 52,500.00
19	Bid Negotiating	1	LS	$ 10,000.00	$ 10,000.00
20	Construction Admin.	1	LS	$ 55,000.00	$ 55,000.00
21	Construction Inspection	1	LS	$ 52,500.00	$ 52,500.00
22	Project Closeout	1	LS	$ 20,000.00	$ 20,000.00
23	Legal Bond Council	1	LS	$ 26,500.00	$ 26,500.00
24	Interim Financing	1	LS	$ 35,000.00	$ 35,000.00
25	Construction Contingency	1	LS	$ 154,050.00	$ 154,050.00
26	Land & Rights-of-Ways	1	LS	$ 0.00	$ 0.00
27	**Non-Construction Cost Estimate**				**$ 465,550.00**
	TOTAL PROJECT COST ESTIMATE				**$ 1,694,550.00**

7) Annual Operating Budget

A) INCOME

Table 55 below shows the estimated income generated in fiscal year 2017. This income is based on the current monthly sewer charge of $ 26.00 per month and an average standby user count of 16 ERUs at $ 16.00 per month. The number of standby users changes continually throughout the year. This table also identifies the proposed income based on a monthly rate increase from $ 26.00 per month to $ 28.00 per month. In addition, the standby charge is proposed to be eliminated resulting in all residents paying the same monthly fee. The anticipated income for fiscal year 2019 is $ 383,376.00 based on $ 28.00 per month and 1,141 equivalent residential users (ERUs). The 1,141 ERUs represents a 4% increase in connections for 2018 as well as an additional 4% increase occurring in 2019. If growth ceased in the City and fiscal year 2019 included the same number of ERUs as fiscal year 2017, the resultant user charge would need to be $ 30.00 per month to generate sufficient revenue to cover the anticipated operation and maintenance costs.

Table 55 - Estimated Revenue from Sewer User Fees

Equivalent Residential Users	Monthly Rate	Annual Income
(FY 2017) 1,039 ERUs	$ 26.00	$ 324,168.00
(FY 2017) 16 ERUs, standby	$ 16.00	$ 3,072.00
(FY 2017) TOTAL		$ 327,240.00
(FY 2019) 1,121 ERUs	$ 28.00	$ 376,656.00
(FY 2019) 20 standby users	$ 28.00	$ 6,720.00
(FY 2019) TOTAL		$ 383,376.00

B) ANNUAL O&M COSTS

Table 56 below represents the actual fiscal year 2017 operation and maintenance costs for the City's sewer system. The projected fiscal year 2019 costs are shown in the right hand column and represents adjustments for inflation, electrical usage, and debt service payments. The fiscal year 2019 costs have been increase by 2% per year to account for inflationary effects.

Table 56 - Operation and Maintenance Expense Budget

Budget Item	Total Expense for FY 2017	Project Expense for FY 2019 (First Full Year After Construction)
Wages	$ 80,559.63	$ 83,782.00
Payroll Taxes	$ 5,662.66	$ 5,889.00
Workers Compensation	$ 4,988.00	$ 5,188.00
Medical Insurance	$ 21,541.59	$ 22,403.00
PERSI Retirement	$ 8,927.15	$ 9,284.00
Unemployment	$ 806.04	$ 838.00
Phone/Fax	$ 1,972.54	$ 2,051.00
Computer Expenses	$ 224.04	$ 233.00
Postage	$ 1,585.77	$ 1,649.00
Utilities	$ 5,321.48	$ 5,534.00
Testing	$ 7,090.00	$ 7,374.00
Power	$ 15,202.67	$ 24,306.00
Office Supplies	$ 848.68	$ 883.00
Operating Supplies	$ 12,602.32	$ 13,106.00
Fuel & Oil	$ 1,696.36	$ 1,764.00
Chlorine	$ 28,128.08	$ 29,253.00
Vehicle Expense	$ 987.40	$ 1,027.00
Publications	$ 1,165.05	$ 1,212.00
Code Publications	$ 114.59	$ 119.00
Dues & Subscriptions	$ 560.47	$ 583.00
Training/Seminars	$ 700.00	$ 728.00
Travel	$ 121.20	$ 126.00
Meals/Ent.	$ 40.75	$ 43.00
Audit Fees	$ 1,310.48	$ 1,363.00
Maintenance/Replacement	$ 43,881.21	$ 45,636.00
Lease/Rental Equipment	$ 1,457.99	$ 1,516.00
Legal Fees	$ 2,799.37	$ 2,911.00
Sewer Loan, Debt Service	$ 64,366.44	$ 77,940.00
Insurance	$ 3,552.81	$ 3,695.00
Backup Operator	$ 3,600.00	$ 3,744.00
Engineering	$ 20,715.75	$ 21,544.00
Impact Fee	$ 307.50	$ 320.00
Misc. Expense	$ 1,889.59	$ 1,965.00
TOTAL	$ 344,727.61	$ 378,009.00

C) DEBT REPAYMENTS

The City currently has one loan for the sewer system. That loan was associated with the construction of Lagoon Cell No. 4 and the plant headworks facility in 2003. The loan is through DEQ and has a current balance of $ 367,526.80. Payments are made two times per year, January and July. It is anticipated that two more payments of $ 32,183.22 will be made on the DEQ loan prior to completion of the proposed Lagoon Cell No. 5 project. The City has applied for a loan in the amount of $1,800,000 to construct Lagoon Cell No. 5 and pay off their existing DEQ loan. The anticipated interest rate for the new loan is 3% with a term of 40 years. The annual payment on the $1,800,000 loan would be $77,940.00. This value is shown in the *Sewer Loan, Debt Service* line item of the budget listed in Table 56 prior.

D) Reserves

1) Debt Service Reserve

The required debt service reserve is equivalent to one year's payment. For the proposed project this will equal $ 77,940.00. The City holds three separate reserve accounts related to the wastewater system. The first account in a bond reserve account associated with the existing DEQ loan. The amount in their bond reserve account is presently $ 24,622.94. The second and third reserve accounts are associated with wastewater system impact fees and connection fees associated with new sewer connections. The impact and connection fee reserve accounts combined currently total approximately $ 273,000.00.

The proposed project will pay off the existing loan, and the existing bond reserve amount of $24,622.94 will be available to apply towards the required debt service reserve of $77,940.00. That will leave a total of $ 53,317.06 to be transferred from the impact and connection fee accounts to the debt service reserve account. The impact fee and connection fee account total will then be $ 273,000.00 - $ 53,317.06 = $ 219,682.94. In the preceding costs estimates in section E.8, a total of $ 200,000.00 was noted as City match from their reserve account in determining the required loan amount for each option.

2) Short Lived Asset Reserve

The short lived asset reserve fund is intended to provide funding to replace existing equipment at a point in time when that equipment fails. The life expectance and equipment costs are simply a best estimation of when replacement will be required and how much money will be necessary. The following Table 57 identifies short lived assets that will be in need of replacement.

Table 57 - Short Lived Assets

Item	Life Expectancy	Expected Replacement Year	Anticipated Equipment Cost	Quantity
Lift Station Pump, Blackwell	15 years	2009	$ 8,000	2
Lift Station Pump, R Ranch	15 years	2021	$ 8,000	2
Lift Station Pump, Spirit Shores	15 years	2023	$ 8,000	4
Influent Flow Meter	20 years	2024	$ 5,000	1
Chlorine Injection Pump	10 years	2026	$ 4,000	1

Chlorine Metering Equipment	10 years	2026	$ 10,000	1
Backup Generator, R Ranch	20 years	2026	$ 30,000	1
Surface Aerators	10 years	2027	$ 12,000	6
Cell No. 4 Drain Pump	15 years	2031	$ 8,000	2
Center Pivot No. 1	30 years	2032	$ 65,000	1
Flow Box Plug Valves	20 years	2032	$ 7,500	6
In Channel Fine Screen	30 years	2034	$ 75,000	1
Irrigation Pump	20 years	2037	$ 26,000	2
Irrigation Booster Pump	20 years	2038	$ 8,000	2
Wastewater Flow Meters	20 years	2038	$ 3,500	7
Irrigation Control System	20 years	2038	$ 25,000	1
Center Pivot No. 2	40 years	2042	$ 60,000	1

Figure 30 displays a graphical example of the short lived assets reserve account needs over the next 25 years. This figure was derived from the values and timelines identified in previous Table 57. A recommended account deposit into the Short Lived Asset Reserve was assumed to be $24,000.00 per year. The account balance ranges from a minimum of $500.00 in year 2038 to a maximum of $ 135,000.00 in the year 2031. Funding for the short-lived asset account would be generated from the monthly fees charged for operation and maintenance. Replacement of the existing equipment is a maintenance expense. The deposit of $ 24,000 per year is equal to just under $ 2.00 per month assuming 1055 ERUs are contributing.

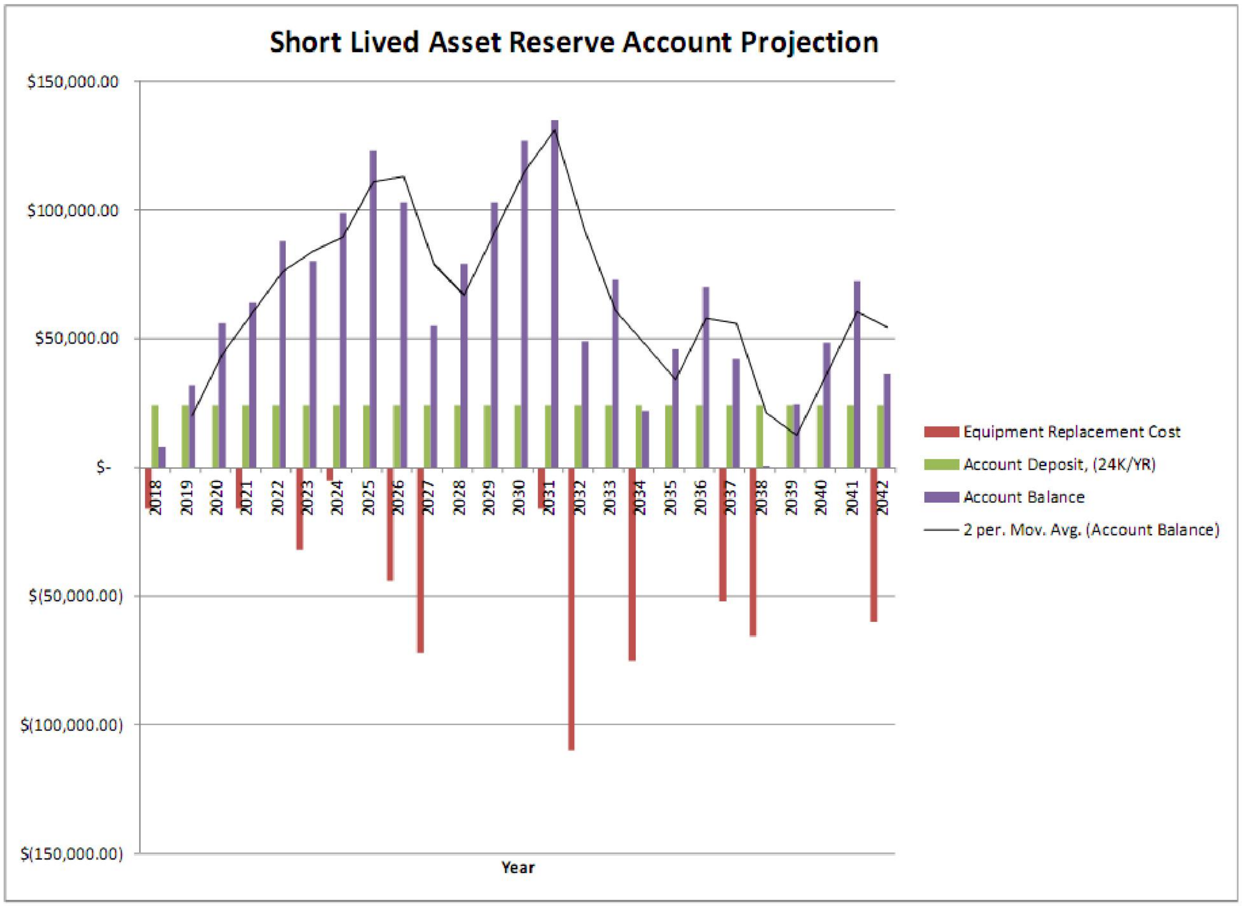


Figure 30 - Short Lived Asset Reserve Fund Projection

8) *Potential Environmental Effects for the Selected Alternative*

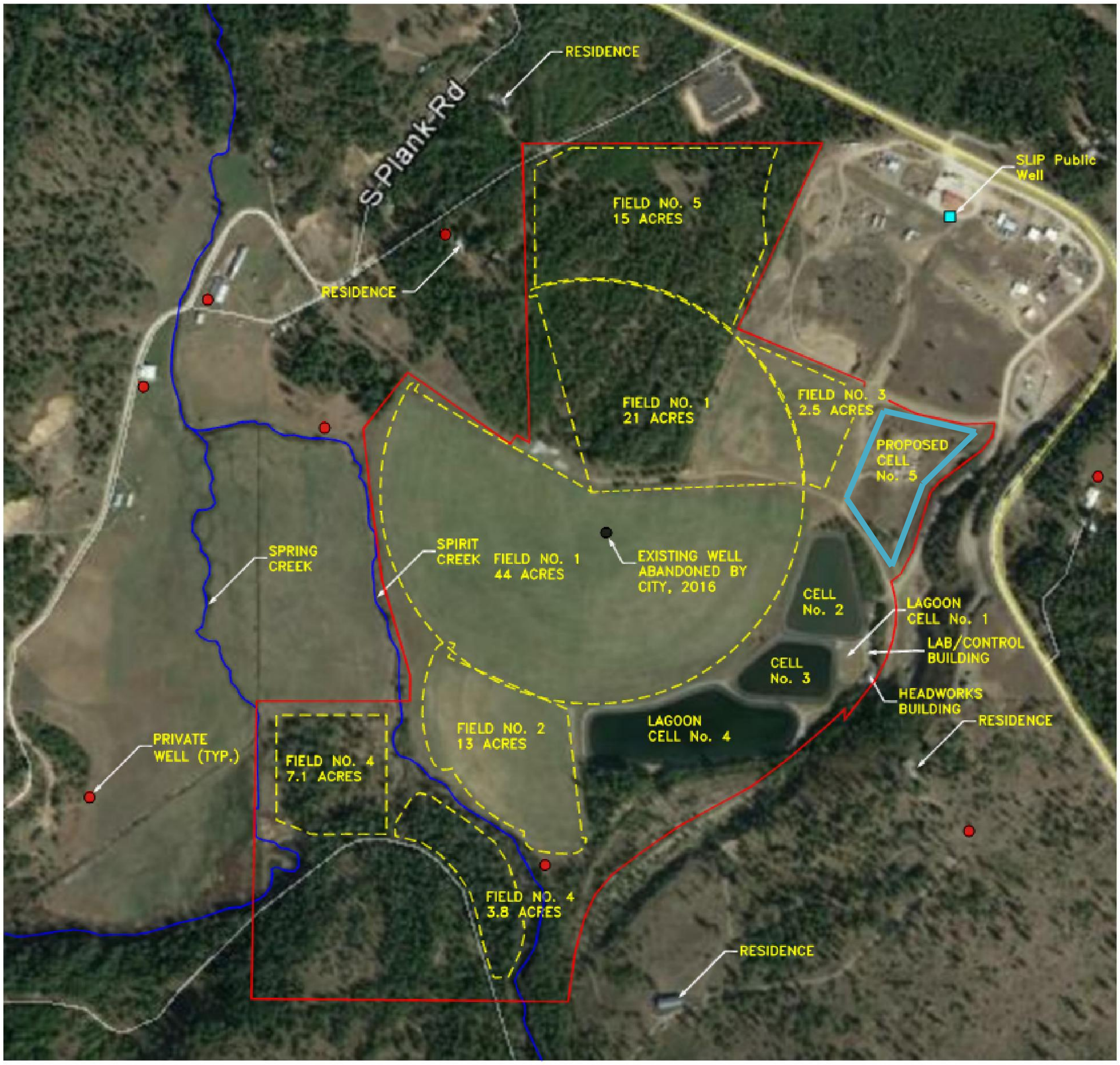


Figure 31 - Aerial View of Wastewater Treatment Plant and Proposed Lagoon Cell No. 5.

As shown in Figure 31 above, the proposed Lagoon Cell No. 5 site is located adjacent to the existing Lagoon Cell No. 2 on a parcel of land that was an existing sand borrow pit. The proposed site was most recently a shooting range prior to acquisition of the property by the City. The lower elevations of the site show evidence of construction debris and trash dumping. Land adjacent to the east is steep topography extending up to the State Highway 41 corridor. Land adjacent to the north is part of the Spirit Lake Industrial Park. The neighboring tenant to the north utilizes several lots within the industrial park for construction of mobile cedar cabins. The west and south boundaries of the proposed lagoon site are bordered by the City's current wastewater treatment facility. The anticipated environmental impacts associated the recommended alternative site are as follows:

Flora and Fauna

Generally, the proposed Lagoon Cell No. 5 site is sparsely covered with pine trees and the boundaries and native grasses and weeds within the property interior. An access road to the wastewater treatment plant exists along the east border of the site. It will be necessary to clear and grub the existing trees and vegetation at the proposed site for earthwork construction. Considering the proposed lot site has been previously been developed into a sand borrow pit, potential impacts to the local flora and fauna are expected to be insignificant.

Surface Water

Currently there is no standing surface water at the Lagoon Cell No. 5 site. Surface water runoff will be controlled through the implementation of Best Management Practices (BMPs) for erosion and sedimentation control. These measures will include the use of rock-lined infiltration areas, Grassy Infiltration Areas (GIAs) and buffer zones. The proposed alternative includes a rock-line infiltration area and a concrete drywell located in the southeast corner of the lot. The drywell and infiltration area will collect stormwater runoff that enters the site beyond the lagoon dikes. Stormwater that falls within the proposed Lagoon Cell No. 5 area will be contained in the lagoon, treated and irrigated with the normal wastewater treatment process. With the implementation of the surface water runoff BMPs, surface water quality and stormwater erosion and runoff is expected to be insignificant.

Ground Water

The proposed Lagoon Cell No. 5 will be constructed with a lagoon leak detection system and double lagoon liner to prevent impacts to area groundwater. The electronic leak detection system will allow for future lagoon leak surveys at any time in the future and as the lagoon is in operation. Three groundwater monitoring wells will be installed to form a monitoring network. One of the wells will be installed upgradient from the treatment plant and two located downgradient. The proposed groundwater monitoring plan has been attached in Appendix D-2. Impacts to ground water quality as a result of the project construction are expected to be insignificant.

Historical and Cultural Resources

The site proposed for Lagoon Cell No. 5 construction includes two lots part of the original Spirit Lake Industrial Park. There are no historical buildings located on the site. Prior activities have disturbed, excavated and removed much of the ground as well as dumped and filled construction debris and garbage on the site. Because of the recent ground disturbing activities, the project is not expected to impact historic buildings or culturally significant artifacts. In the event that a culturally significant artifact is discovered during project construction, an archaeological expert will be contacted and project construction will be halted pending expert evaluation of the find.

Air Quality

The potential of the recommended project to impact air quality would be limited to the minor dust pollution attributed to construction activities. Any dust emissions will be mitigated by wetting of the construction area as required to minimize off-site dust migration.

H. Conclusions and Recommendations

The recommended plan of action includes:

STEP 1 – STORAGE ADDITION

1) **Installation of proposed Lagoon Cell No. 5** as outlined under storage alternative S1,
   Priority – Immediate Need
   Timing – Proposed Construction summer of 2018

STEP 2 – TREATMENT DEFICIENCIES

2) **Installation of aeration in Lagoon Cell No. 4**,
   Priority – Immediate Need
   Timing – Pending

3) **Expanding the chlorine contact piping system and,**
   Priority – Immediate Need
   Timing – Bid for Construction 2017, Rebid Pending

4) **Installation of the proposed manifold to Field No. 4.**
   Priority – Immediate Need
   Timing – Proposed City Project, 2018

The proposed manifold serving Field No. 4 should be installed with the chlorine contact piping project extension as both of these projects will disrupt the irrigation system operation and are similar in construction nature.

STEP 3 – STORAGE EXPANSION & MAINTENANCE

5) **Cleaning, Expansion and Liner Replacement in Lagoon Cell No. 2.**
   Priority – Needed following construction of Lagoon Cell No. 5
   Timing – Proposed Construction 2019

The Lagoon Cell No. 2 project will include cleaning and removal of the sludge, deepening, and installation of a new liner system. The Lagoon Cell No. 2 project will provide a number of much needed improvements to the system. The current sludge depth is affecting the treatment plant performance, the existing liner system is past it useful life, and the opportunity to install aeration in this cell will allow the treatment started in Lagoon Cell No. 1 to continue through the process.

STEP 4 – TREATMENT IMPROVEMENTS

6) **Installation of aeration in Lagoon Cell No. 2**
   Priority – Needed following installation of aeration in Lagoon Cell No. 4
   Timing – Proposed construction within 5 years

7) **Installation of aeration in Lagoon Cell No. 5**
   Priority – Needed following installation of aeration in Lagoon Cell No. 2
   Timing – Proposed construction within 5 years

STEP 5 – FACILITY LONG TERM EXPANSION

It is also recommended to continue with long term plans to acquire additional properties to expand the wastewater land application system in the future. By the year 2025 the land application system will once again, be at capacity assuming a controlled 4% growth rate. By the year 2028 the additional capacity gained through installation of Lagoon Cell No. 5 will be consumed. The long term plans of acquiring a large tract of land from the U.S. Forest Service would provide the City with some breathing room to plan and implement projects covering a 20 year planning cycle instead of projects with 5 or 10 year capacities.

Priority – Needed by 2025
Timing – Begin Construction within 6 years

Appendix Directory

Appendix B-1

NRCS Project Area Survey Report
City Limits

James A. Sewell & Associates, LLC

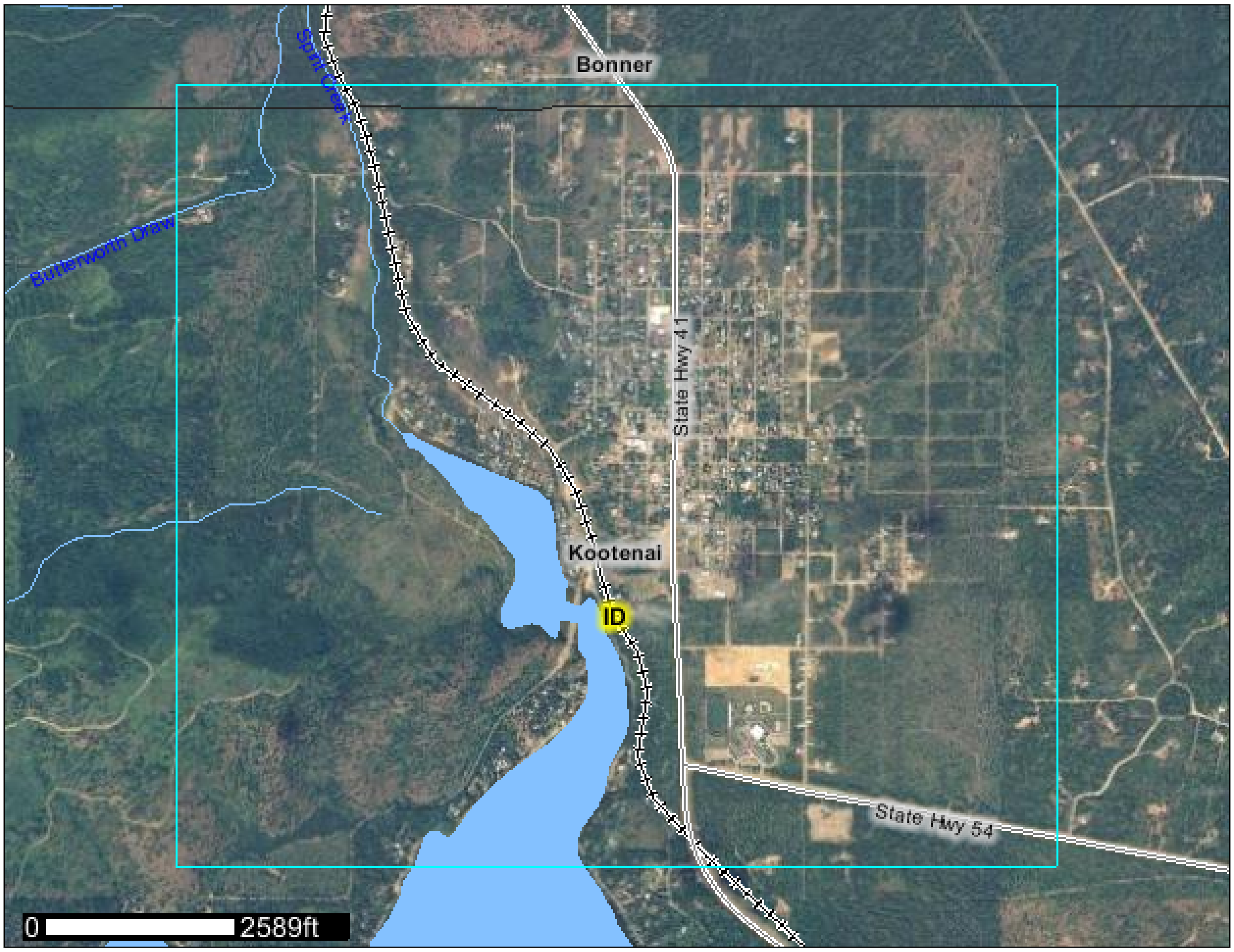
United States
Department of
Agriculture

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Bonner County Area, Idaho, Parts of Bonner and Boundary Counties; and Kootenai County Area, Idaho

City of Spirit Lake



July 31, 2012

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

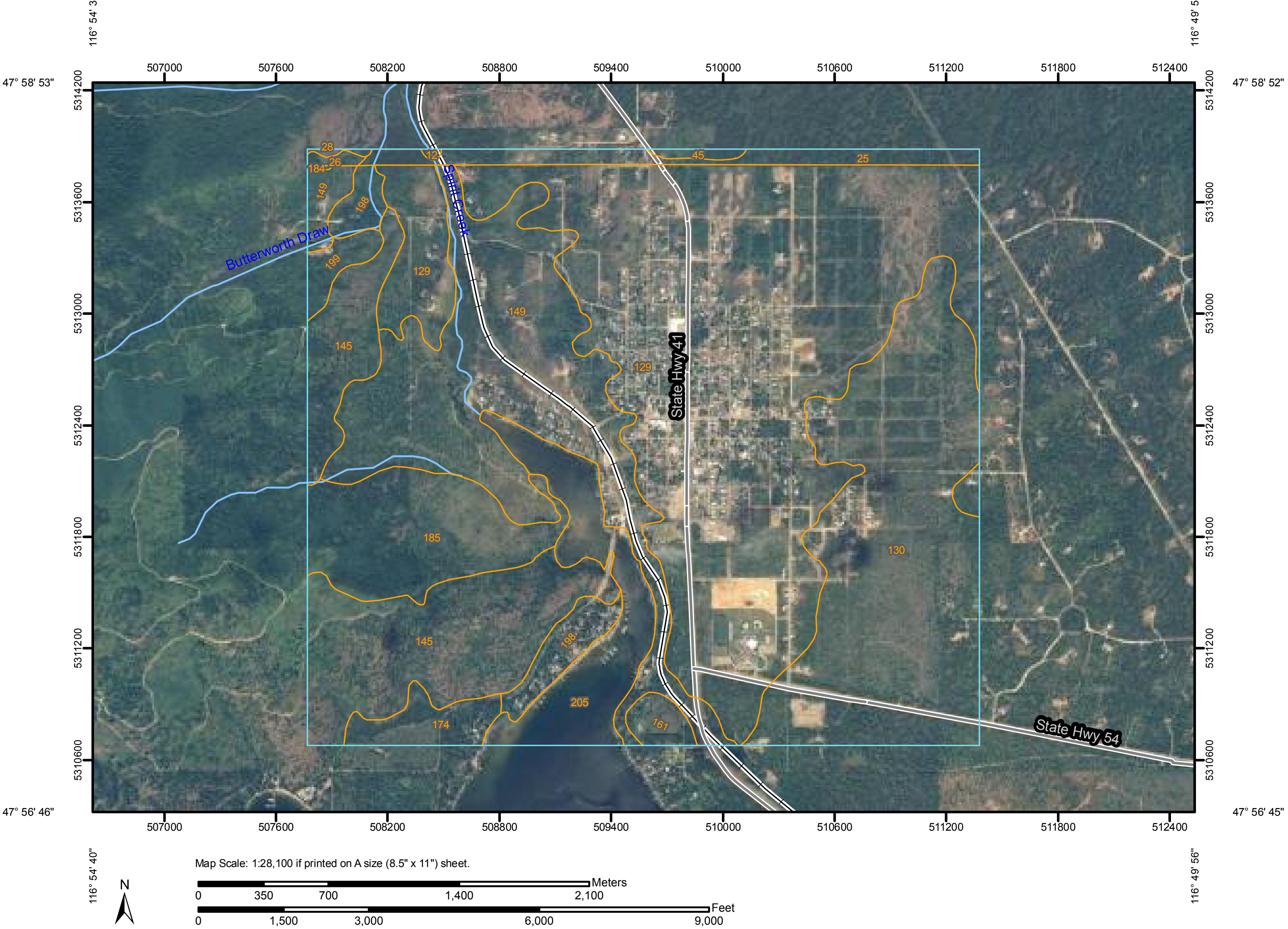
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:28,100 if printed on A size (8.5" x 11") sheet.

MAP LEGEND

Area of Interest (AOI)

- ☐ Area of Interest (AOI)

Soils

- ☐ Soil Map Units

Special Point Features

- Blowout
- ☒ Borrow Pit
- Clay Spot
- ◆ Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- + Saline Spot
- Sandy Spot
- Severely Eroded Spot
- ◇ Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- ▲ Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- ● Cities

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:28,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 6, Jan 31, 2008

Soil Survey Area: Kootenai County Area, Idaho
Survey Area Data: Version 6, Jan 31, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 6/23/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Bonner County Area, Idaho, Parts of Bonner and Boundary Counties (ID604)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12	Elmira loamy sand, 0 to 8 percent slopes	1.2	0.0%
25	Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes	61.8	2.2%
26	Kruse silt loam, 30 to 65 percent slopes	4.6	0.2%
28	Lenz-Rock outcrop association, 30 to 65 percent slopes	2.4	0.1%
45	Rathdrum-Bonner silt loams, 0 to 8 percent slopes	6.3	0.2%
Subtotals for Soil Survey Area		**76.3**	**2.7%**
Totals for Area of Interest		**2,865.3**	**100.0%**

Kootenai County Area, Idaho (ID606)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
129	Kootenai-Bonner complex, 0 to 20 percent slopes	1,064.5	37.2%
130	Kootenai-Rathdrum association, 0 to 20 percent slopes	502.7	17.5%
145	Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes	314.3	11.0%
149	McGuire-Marble association, 0 to 7 percent slopes	451.0	15.7%
161	Rathdrum silt loam, 0 to 7 percent slopes	19.6	0.7%
174	Selle fine sandy loam, 0 to 7 percent slopes	42.5	1.5%
184	Spokane loam, 30 to 65 percent slopes	0.3	0.0%
185	Spokane-Moscow association, 35 to 65 percent slopes	171.4	6.0%
198	Vassar silt loam, 5 to 30 percent slopes	55.6	1.9%
199	Vassar silt loam, 30 to 65 percent slopes	21.4	0.7%
205	Water	145.8	5.1%
Subtotals for Soil Survey Area		**2,788.9**	**97.3%**
Totals for Area of Interest		**2,865.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

12—Elmira loamy sand, 0 to 8 percent slopes

Map Unit Setting

Elevation: 200 to 2,700 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 110 to 140 days

Map Unit Composition

Elmira and similar soils: 80 percent

Description of Elmira

Setting

Landform: Terraces, dunes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Volcanic ash and loess over sandy glaciolacustrine deposits

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 5 inches: Loamy sand
5 to 26 inches: Loamy sand
26 to 60 inches: Loamy sand

25—Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes

Map Unit Setting

Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Kootenai and similar soils: 50 percent
Bonner and similar soils: 35 percent

Description of Kootenai

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or gneiss and/or schist

Properties and qualities

Slope: 0 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 6 inches: Gravelly silt loam
6 to 17 inches: Gravelly silt loam
17 to 27 inches: Very gravelly sandy loam
27 to 60 inches: Extremely gravelly loamy coarse sand

Description of Bonner

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or schist and/or gneiss

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3s

Land capability (nonirrigated): 4s

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 6 inches: Gravelly silt loam
6 to 22 inches: Gravelly silt loam
22 to 30 inches: Gravelly loam
30 to 60 inches: Very gravelly loamy sand

26—Kruse silt loam, 30 to 65 percent slopes

Map Unit Setting

Elevation: 2,200 to 3,800 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Kruse and similar soils: 80 percent

Description of Kruse

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Volcanic ash and/or loess over mixed colluvium

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 11.7 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 16 inches: Silt loam
16 to 52 inches: Clay loam
52 to 60 inches: Gravelly sandy loam

28—Lenz-Rock outcrop association, 30 to 65 percent slopes

Map Unit Setting

Elevation: 2,500 to 4,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 130 days

Map Unit Composition

Lenz and similar soils: 45 percent
Rock outcrop: 25 percent

Description of Lenz

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over bedrock derived from granite and/or gneiss and/or schist

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.4 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 7 inches: Stony sandy loam
7 to 24 inches: Very gravelly sandy loam
24 to 34 inches: Unweathered bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Typical profile

0 to 60 inches: Unweathered bedrock

45—Rathdrum-Bonner silt loams, 0 to 8 percent slopes

Map Unit Setting

Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 38 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Rathdrum and similar soils: 40 percent
Bonner and similar soils: 35 percent
Minor components: 5 percent

Description of Rathdrum

Setting

Landform: Depressions, outwash terraces
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over alluvium and/or outwash

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): 3c
Land capability (nonirrigated): 3c

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 18 inches: Silt loam
18 to 39 inches: Silt loam
39 to 61 inches: Silt loam

Description of Bonner

Setting

Landform: Outwash terraces
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or schist and/or gneiss

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 6 inches: Silt loam
6 to 22 inches: Gravelly silt loam
22 to 30 inches: Gravelly loam
30 to 60 inches: Very gravelly loamy sand

Minor Components

Hoodoo

Percent of map unit: 5 percent
Landform: Depressions

Kootenai County Area, Idaho

129—Kootenai-Bonner complex, 0 to 20 percent slopes

Map Unit Setting

Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Kootenai and similar soils: 60 percent
Bonner and similar soils: 30 percent

Description of Kootenai

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or gneiss and/or schist

Properties and qualities

Slope: 0 to 20 percent
Depth to restrictive feature: 20 to 36 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 8 inches: Gravelly silt loam
8 to 24 inches: Gravelly silt loam
24 to 28 inches: Very gravelly loam
28 to 62 inches: Extremely gravelly coarse sand

Description of Bonner

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or schist and/or gneiss

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 24 to 36 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 10 inches: Gravelly silt loam
10 to 20 inches: Gravelly silt loam
20 to 28 inches: Gravelly sandy loam
28 to 62 inches: Very gravelly loamy sand

130—Kootenai-Rathdrum association, 0 to 20 percent slopes

Map Unit Setting

Elevation: 2,000 to 2,700 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Kootenai and similar soils: 60 percent
Rathdrum and similar soils: 30 percent

Description of Kootenai

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or gneiss and/or schist

Properties and qualities

Slope: 0 to 20 percent
Depth to restrictive feature: 20 to 36 inches to strongly contrasting textural stratification
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 8 inches: Gravelly silt loam
8 to 24 inches: Gravelly silt loam
24 to 28 inches: Very gravelly loam
28 to 62 inches: Extremely gravelly coarse sand

Description of Rathdrum

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over alluvium and/or outwash

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): 3c
Land capability (nonirrigated): 3c

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 24 inches: Silt loam
24 to 46 inches: Silt loam
46 to 56 inches: Very fine sandy loam
56 to 62 inches: Silt loam

145—Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes

Map Unit Setting

Elevation: 1,800 to 4,000 feet
Mean annual precipitation: 15 to 28 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 140 days

Map Unit Composition

Lenz and similar soils: 45 percent
Spokane and similar soils: 25 percent
Rock outcrop: 20 percent

Description of Lenz

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over bedrock derived from granite and/or gneiss and/or schist

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.2 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 7 inches: Loam
7 to 12 inches: Loam
12 to 23 inches: Very gravelly sandy loam
23 to 36 inches: Extremely stony sandy loam
36 to 46 inches: Unweathered bedrock

Description of Spokane

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Linear

Parent material: Loess over residuum weathered from granite and/or gneiss and/or schist

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.5 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Loam
9 to 28 inches: Gravelly loam
28 to 38 inches: Weathered bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability (nonirrigated): 8

Typical profile

0 to 60 inches: Unweathered bedrock

149—McGuire-Marble association, 0 to 7 percent slopes

Map Unit Setting

Elevation: 1,500 to 2,500 feet
Mean annual precipitation: 15 to 26 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 110 to 150 days

Map Unit Composition

Mcguire and similar soils: 60 percent
Marble and similar soils: 30 percent

Description of Mcguire

Setting

Landform: Outwash terraces

Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Gravelly sandy loam
9 to 23 inches: Very gravelly sandy loam
23 to 27 inches: Extremely gravelly coarse sandy loam
27 to 61 inches: Extremely gravelly coarse sand

Description of Marble

Setting

Landform: Outwash terraces
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Reworked sandy outwash

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e

Typical profile

0 to 2 inches: Slightly decomposed plant material
2 to 3 inches: Moderately decomposed plant material
3 to 9 inches: Sandy loam
9 to 63 inches: Loamy sand

161—Rathdrum silt loam, 0 to 7 percent slopes

Map Unit Setting

Elevation: 2,000 to 2,600 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 110 days

Map Unit Composition

Rathdrum and similar soils: 85 percent

Description of Rathdrum

Setting

Landform: Outwash terraces, depressions
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over alluvium and/or outwash

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): 3c
Land capability (nonirrigated): 3c

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 24 inches: Silt loam
24 to 46 inches: Silt loam
46 to 56 inches: Very fine sandy loam
56 to 62 inches: Silt loam

174—Selle fine sandy loam, 0 to 7 percent slopes

Map Unit Setting

Elevation: 2,000 to 2,500 feet

Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 100 to 130 days

Map Unit Composition

Selle and similar soils: 75 percent

Description of Selle

Setting

Landform: Terraces
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over sandy glaciolacustrine deposits

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.9 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability (nonirrigated): 3s

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 19 inches: Fine sandy loam
19 to 26 inches: Fine sandy loam
26 to 60 inches: Loamy fine sand

184—Spokane loam, 30 to 65 percent slopes

Map Unit Setting

Elevation: 1,800 to 3,000 feet
Mean annual precipitation: 15 to 24 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 140 days

Map Unit Composition

Spokane and similar soils: 85 percent

Description of Spokane

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Loess over residuum weathered from granite and/or gneiss and/or schist

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.5 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Loam
9 to 28 inches: Gravelly loam
28 to 38 inches: Weathered bedrock

185—Spokane-Moscow association, 35 to 65 percent slopes

Map Unit Setting

Elevation: 1,800 to 5,000 feet
Mean annual precipitation: 15 to 30 inches
Mean annual air temperature: 43 to 48 degrees F
Frost-free period: 80 to 140 days

Map Unit Composition

Spokane and similar soils: 45 percent
Moscow and similar soils: 35 percent

Description of Spokane

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over residuum weathered from granite and/or gneiss and/or schist

Properties and qualities

Slope: 35 to 65 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.5 inches)

Interpretive groups
Land capability (nonirrigated): 7e

Typical profile
0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Loam
9 to 28 inches: Gravelly loam
28 to 38 inches: Weathered bedrock

Description of Moscow

Setting
Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Volcanic ash and loess over residuum weathered from schist and/or gneiss and/or granite

Properties and qualities
Slope: 35 to 65 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 6.0 inches)

Interpretive groups
Land capability (nonirrigated): 7e

Typical profile
0 to 2 inches: Slightly decomposed plant material
2 to 3 inches: Moderately decomposed plant material
3 to 4 inches: Loam
4 to 26 inches: Loam
26 to 29 inches: Gravelly sandy loam
29 to 39 inches: Weathered bedrock

198—Vassar silt loam, 5 to 30 percent slopes

Map Unit Setting

Elevation: 2,500 to 5,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 37 to 45 degrees F
Frost-free period: 50 to 90 days

Map Unit Composition

Vassar and similar soils: 75 percent

Description of Vassar

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Volcanic ash over residuum weathered from granite and/or gneiss and/or schist

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.7 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 22 inches: Silt loam
22 to 62 inches: Coarse sandy loam

199—Vassar silt loam, 30 to 65 percent slopes

Map Unit Setting

Elevation: 2,500 to 5,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 37 to 45 degrees F
Frost-free period: 50 to 90 days

Map Unit Composition

Vassar and similar soils: 75 percent

Description of Vassar

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Concave

Parent material: Volcanic ash over residuum weathered from granite and/or gneiss and/or schist

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.7 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 2 inches: Moderately decomposed plant material
2 to 22 inches: Silt loam
22 to 62 inches: Coarse sandy loam

205—Water

Map Unit Composition

Water: 100 percent

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

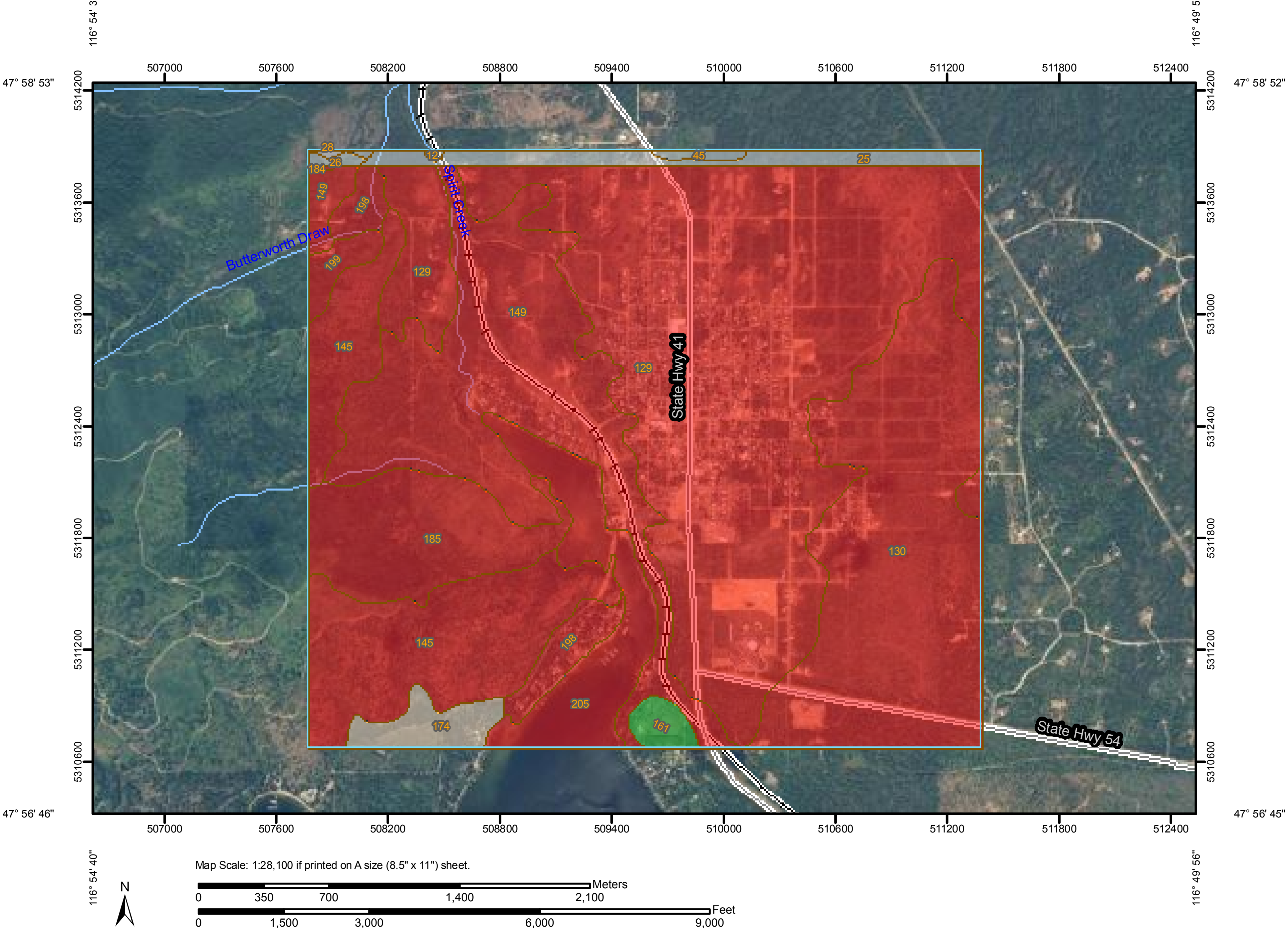
Land Classifications

Land Classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Farmland Classification (Spirit Lake Farmland)

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

Map—Farmland Classification (Spirit Lake Farmland)



Map Scale: 1:28,100 if printed on A size (8.5" x 11") sheet.

MAP LEGEND

Area of Interest (AOI)

- ☐ Area of Interest (AOI)

Soils

- ☐ Soil Map Units

Soil Ratings

- 🟥 Not prime farmland
- 🟩 All areas are prime farmland
- 🟥 Prime farmland if drained
- ⬜ Prime farmland if protected from flooding or not frequently flooded during the growing season
- ⬜ Prime farmland if irrigated
- 🟦 Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- 🟦 Prime farmland if irrigated and drained
- 🟦 Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- 🟦 Prime farmland if subsoiled, completely removing the root inhibiting soil layer
- 🟦 Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- 🟩 Prime farmland if irrigated and reclaimed of excess salts and sodium
- 🟩 Farmland of statewide importance
- 🟨 Farmland of local importance
- 🟨 Farmland of unique importance
- ⬜ Not rated or not available

Political Features

- ● Cities

Water Features

- ∿ Streams and Canals

Transportation

- ╪ Rails
- ∿ Interstate Highways
- ∿ US Routes
- ∿ Major Roads
- ∿ Local Roads

MAP INFORMATION

Map Scale: 1:28,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 6, Jan 31, 2008

Soil Survey Area: Kootenai County Area, Idaho
Survey Area Data: Version 6, Jan 31, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 6/23/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Farmland Classification (Spirit Lake Farmland)

Farmland Classification— Summary by Map Unit — Bonner County Area, Idaho, Parts of Bonner and Boundary Counties (ID604)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
12	Elmira loamy sand, 0 to 8 percent slopes		1.2	0.0%
25	Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes		61.8	2.2%
26	Kruse silt loam, 30 to 65 percent slopes		4.6	0.2%
28	Lenz-Rock outcrop association, 30 to 65 percent slopes		2.4	0.1%
45	Rathdrum-Bonner silt loams, 0 to 8 percent slopes		6.3	0.2%
Subtotals for Soil Survey Area			**76.3**	**2.7%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Farmland Classification— Summary by Map Unit — Kootenai County Area, Idaho (ID606)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
129	Kootenai-Bonner complex, 0 to 20 percent slopes	Not prime farmland	1,064.5	37.2%
130	Kootenai-Rathdrum association, 0 to 20 percent slopes	Not prime farmland	502.7	17.5%
145	Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes	Not prime farmland	314.3	11.0%
149	McGuire-Marble association, 0 to 7 percent slopes	Not prime farmland	451.0	15.7%
161	Rathdrum silt loam, 0 to 7 percent slopes	All areas are prime farmland	19.6	0.7%
174	Selle fine sandy loam, 0 to 7 percent slopes	Prime farmland if irrigated	42.5	1.5%
184	Spokane loam, 30 to 65 percent slopes	Not prime farmland	0.3	0.0%
185	Spokane-Moscow association, 35 to 65 percent slopes	Not prime farmland	171.4	6.0%
198	Vassar silt loam, 5 to 30 percent slopes	Not prime farmland	55.6	1.9%
199	Vassar silt loam, 30 to 65 percent slopes	Not prime farmland	21.4	0.7%
205	Water	Not prime farmland	145.8	5.1%
Subtotals for Soil Survey Area			**2,788.9**	**97.3%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Rating Options—Farmland Classification (Spirit Lake Farmland)

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Lower

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Water Features

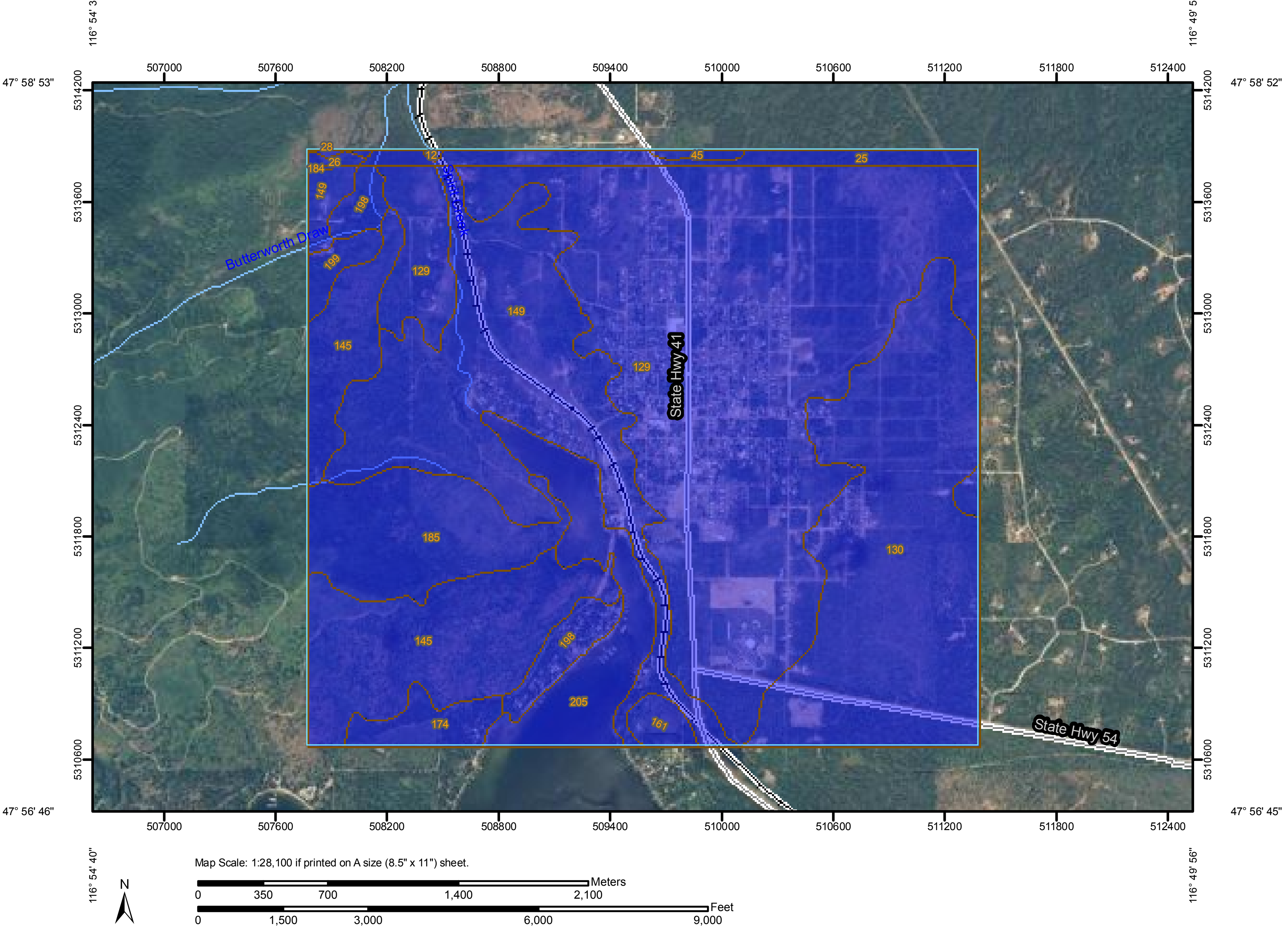
Water Features include ponding frequency, flooding frequency, and depth to water table.

Depth to Water Table (Spirit Lake Water Table)

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Custom Soil Resource Report
Map—Depth to Water Table (Spirit Lake Water Table)



Map Scale: 1:28,100 if printed on A size (8.5" x 11") sheet.

MAP LEGEND

Area of Interest (AOI)

- ☐ Area of Interest (AOI)

Soils

- ☐ Soil Map Units

Soil Ratings

- 🟥 0 - 25
- 🟧 25 - 50
- 🟨 50 - 100
- 🟩 100 - 150
- 🟦 150 - 200
- 🟦 > 200

Political Features

- ● Cities

Water Features

- ~ Streams and Canals

Transportation

- ┼┼┼ Rails
- ~ Interstate Highways
- ~ US Routes
- ≈ Major Roads
- ~ Local Roads

MAP INFORMATION

Map Scale: 1:28,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 6, Jan 31, 2008

Soil Survey Area: Kootenai County Area, Idaho
Survey Area Data: Version 6, Jan 31, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 6/23/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Depth to Water Table (Spirit Lake Water Table)

Depth to Water Table— Summary by Map Unit — Bonner County Area, Idaho, Parts of Bonner and Boundary Counties (ID604)

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
12	Elmira loamy sand, 0 to 8 percent slopes	>200	1.2	0.0%
25	Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes	>200	61.8	2.2%
26	Kruse silt loam, 30 to 65 percent slopes	>200	4.6	0.2%
28	Lenz-Rock outcrop association, 30 to 65 percent slopes	>200	2.4	0.1%
45	Rathdrum-Bonner silt loams, 0 to 8 percent slopes	>200	6.3	0.2%
Subtotals for Soil Survey Area			**76.3**	**2.7%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Depth to Water Table— Summary by Map Unit — Kootenai County Area, Idaho (ID606)

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
129	Kootenai-Bonner complex, 0 to 20 percent slopes	>200	1,064.5	37.2%
130	Kootenai-Rathdrum association, 0 to 20 percent slopes	>200	502.7	17.5%
145	Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes	>200	314.3	11.0%
149	McGuire-Marble association, 0 to 7 percent slopes	>200	451.0	15.7%
161	Rathdrum silt loam, 0 to 7 percent slopes	>200	19.6	0.7%
174	Selle fine sandy loam, 0 to 7 percent slopes	>200	42.5	1.5%
184	Spokane loam, 30 to 65 percent slopes	>200	0.3	0.0%
185	Spokane-Moscow association, 35 to 65 percent slopes	>200	171.4	6.0%
198	Vassar silt loam, 5 to 30 percent slopes	>200	55.6	1.9%
199	Vassar silt loam, 30 to 65 percent slopes	>200	21.4	0.7%
205	Water	>200	145.8	5.1%
Subtotals for Soil Survey Area			**2,788.9**	**97.3%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Rating Options—Depth to Water Table (Spirit Lake Water Table)

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Flooding Frequency Class (Spirit Lake Flooding)

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

"None" means that flooding is not probable. The chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years.

"Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1 percent in any year.

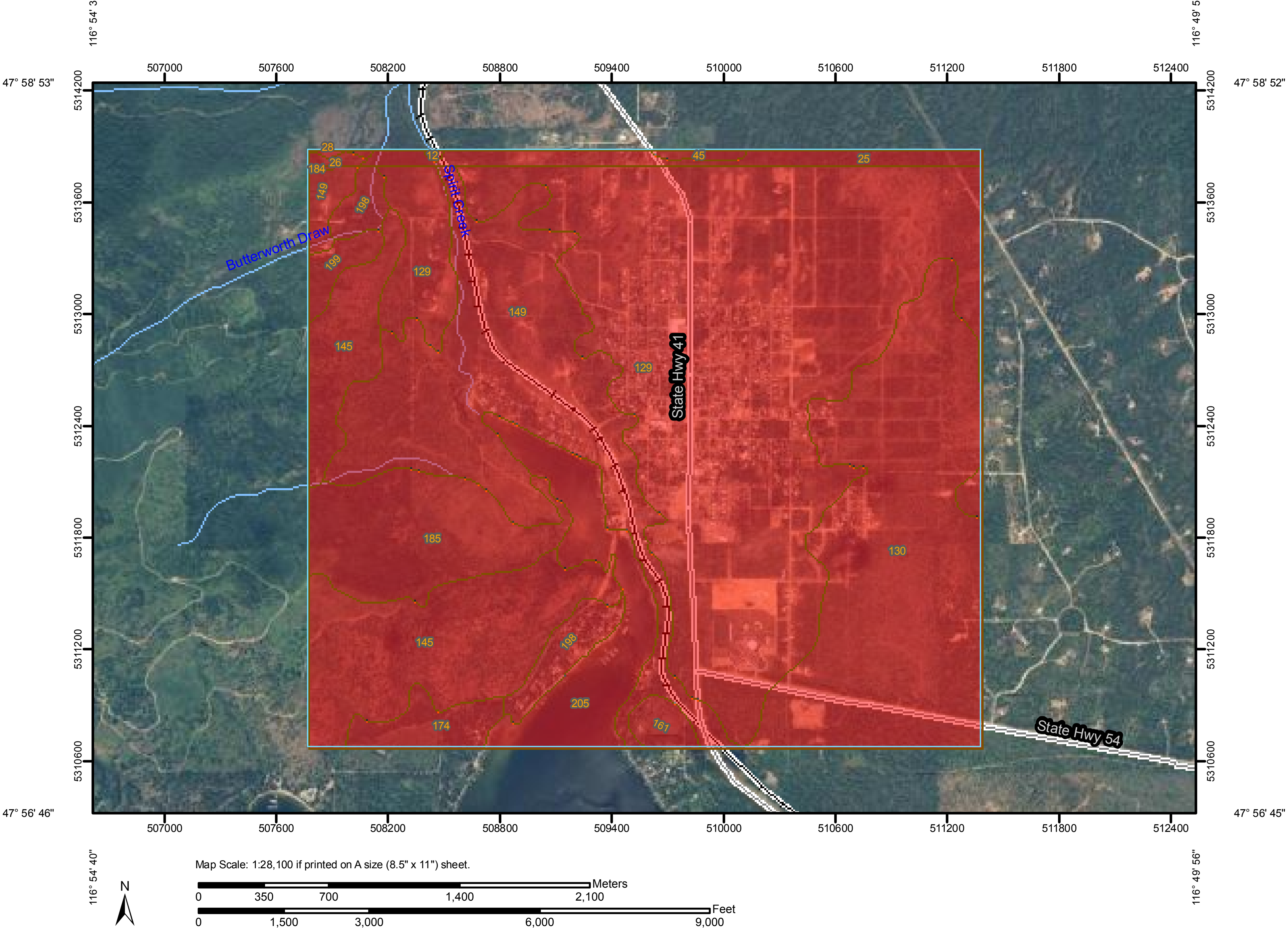
"Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1 to 5 percent in any year.

"Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5 to 50 percent in any year.

"Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year.

"Very frequent" means that flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50 percent in all months of any year.

Map—Flooding Frequency Class (Spirit Lake Flooding)



Map Scale: 1:28,100 if printed on A size (8.5" x 11") sheet.

MAP LEGEND

Area of Interest (AOI)

- ☐ Area of Interest (AOI)

Soils

- ☐ Soil Map Units

Soil Ratings

- 🟥 None
- 🟧 Very Rare
- 🟨 Rare
- 🟩 Occasional
- 🟦 Frequent
- 🟦 Very Frequent

Political Features

- ● Cities

Water Features

- ～ Streams and Canals

Transportation

- ┼┼┼ Rails
- 〰 Interstate Highways
- 〰 US Routes
- 〰 Major Roads
- 〰 Local Roads

MAP INFORMATION

Map Scale: 1:28,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 6, Jan 31, 2008

Soil Survey Area: Kootenai County Area, Idaho
Survey Area Data: Version 6, Jan 31, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 6/23/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Flooding Frequency Class (Spirit Lake Flooding)

Flooding Frequency Class— Summary by Map Unit — Bonner County Area, Idaho, Parts of Bonner and Boundary Counties (ID604)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
12	Elmira loamy sand, 0 to 8 percent slopes	None	1.2	0.0%
25	Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes	None	61.8	2.2%
26	Kruse silt loam, 30 to 65 percent slopes	None	4.6	0.2%
28	Lenz-Rock outcrop association, 30 to 65 percent slopes	None	2.4	0.1%
45	Rathdrum-Bonner silt loams, 0 to 8 percent slopes	None	6.3	0.2%
Subtotals for Soil Survey Area			**76.3**	**2.7%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Flooding Frequency Class— Summary by Map Unit — Kootenai County Area, Idaho (ID606)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
129	Kootenai-Bonner complex, 0 to 20 percent slopes	None	1,064.5	37.2%
130	Kootenai-Rathdrum association, 0 to 20 percent slopes	None	502.7	17.5%
145	Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes	None	314.3	11.0%
149	McGuire-Marble association, 0 to 7 percent slopes	None	451.0	15.7%
161	Rathdrum silt loam, 0 to 7 percent slopes	None	19.6	0.7%
174	Selle fine sandy loam, 0 to 7 percent slopes	None	42.5	1.5%
184	Spokane loam, 30 to 65 percent slopes	None	0.3	0.0%
185	Spokane-Moscow association, 35 to 65 percent slopes	None	171.4	6.0%
198	Vassar silt loam, 5 to 30 percent slopes	None	55.6	1.9%
199	Vassar silt loam, 30 to 65 percent slopes	None	21.4	0.7%
205	Water	None	145.8	5.1%
Subtotals for Soil Survey Area			**2,788.9**	**97.3%**
Totals for Area of Interest			**2,865.3**	**100.0%**

Rating Options—Flooding Frequency Class (Spirit Lake Flooding)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: More Frequent

Beginning Month: January

Ending Month: December

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Land Classifications

This folder contains a collection of tabular reports that present a variety of soil groupings. The reports (tables) include all selected map units and components for each map unit. Land classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Hydric Soils (Spirit Lake Hydric Soils.)

This table lists the map unit components that are rated as hydric soils in the survey area. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; Hurt and others, 2002).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil

Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2B3). Definitions for the codes are as follows:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, or Andic, Cumulic, Pachic, or Vitrandic subgroups that:
    A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
    B. are poorly drained or very poorly drained and have either:
        i. a water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
        ii. a water table at a depth of 0.5 foot or less during the growing season if saturated hydraulic conductivity (Ksat) is equal to or greater than 6.0 in/hr in all layers within a depth of 20 inches, or
        iii. a water table at a depth of 1.0 foot or less during the growing season if saturated hydraulic conductivity (Ksat) is less than 6.0 in/hr in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for long or very long duration during the growing season.
4. Soils that are frequently flooded for long or very long duration during the growing season.

References:

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
Federal Register. September 18, 2002. Hydric soils of the United States.
Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
National Research Council. 1995. Wetlands: Characteristics and boundaries.
Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.
Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.
Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.
Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

Report—Hydric Soils (Spirit Lake Hydric Soils.)

Hydric Soils– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties				
Map symbol and map unit name	**Component**	**Percent of map unit**	**Landform**	**Hydric criteria**
45—Rathdrum-Bonner silt loams, 0 to 8 percent slopes				
	Hoodoo	5	Depressions	2B3

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (Spirit Lake Soil Properties)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash.

Engineering Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
12—Elmira loamy sand, 0 to 8 percent slopes												
Elmira	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-5	*Loamy sand	SM	A-2	0	0	100	100	65-75	20-35	0-0	NP
	5-26	*Loamy sand	SM	A-2	0	0	100	100	65-75	20-35	0-0	NP
	26-60	*Loamy sand, Sand, loamy fine sand	SM, SP-SM	A-2, A-3	0	0	100	100	60-75	5-30	0-0	NP

Engineering Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
25—Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes												
Kootenai	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-6	*Gravelly silt loam	GM, ML	A-4	0	0-10	60-80	55-75	50-70	40-65	20-40	NP-5
	6-17	*Gravelly silt loam, Gravelly loam, gravelly sandy loam	GM, SM	A-1, A-2, A-4	0	0-10	55-75	50-70	35-65	20-50	15-20	NP
	17-27	*Very gravelly sandy loam, Very gravelly loam	GM	A-1, A-2	0	10-25	45-60	40-55	25-45	10-35	15-20	NP
	27-60	*Extremely gravelly loamy coarse sand, Extremely gravelly coarse sand	GP	A-1	0-5	10-45	15-30	10-25	5-15	0-5	0-0	NP
Bonner	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-6	*Gravelly silt loam	GM, ML, SM	A-4	0	0-15	55-75	50-70	45-70	40-65	30-40	NP-5
	6-22	*Gravelly silt loam, Gravelly loam, silt loam	GM, ML, SM	A-4	0	0-15	60-90	55-85	50-80	40-70	30-40	NP-5
	22-30	*Gravelly loam, Gravelly sandy loam	GM, SM	A-4, A-2	0	0-15	55-80	50-75	40-65	30-50	15-20	NP
	30-60	*Very gravelly loamy sand, Extremely gravelly coarse sand, very gravelly sand	GP, GP-GM, GM	A-1	0	0-30	20-50	15-45	10-30	0-15	0-0	NP

Engineering Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties												
Map unit symbol and soil name	**Depth**	**USDA texture**	**Classification**		**Fragments**		**Percentage passing sieve number—**				**Liquid limit**	**Plasticity index**
			Unified	**AASHTO**	**>10 inches**	**3-10 inches**	**4**	**10**	**40**	**200**		
	In				*Pct*	*Pct*					*Pct*	
26—Kruse silt loam, 30 to 65 percent slopes												
Kruse	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-16	*Silt loam	CL-ML	A-4	0	0	95-100	90-100	80-100	60-90	20-30	5-10
	16-52	*Clay loam, Silty clay loam, loam	CL	A-6	0	0	80-100	75-100	70-100	55-85	25-35	10-20
	52-60	*Gravelly sandy loam, Fine sandy loam	ML, SM	A-2, A-4	0	0-15	75-100	70-100	50-80	25-55	15-20	NP-5
28—Lenz-Rock outcrop association, 30 to 65 percent slopes												
Lenz	0-7	*Stony sandy loam	SM	A-1, A-2	5-10	5-10	65-80	60-75	35-50	15-30	0-15	NP
	7-24	*Very gravelly sandy loam, Extremely gravelly sandy loam, very cobbly sandy loam	GM	A-1, A-2	5-15	5-35	30-55	25-50	15-40	10-30	0-15	NP
	24-34	*Unweathered bedrock	—	—	—	—	—	—	—	—	—	—
Rock outcrop	0-60	*Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
45—Rathdrum-Bonner silt loams, 0 to 8 percent slopes												
Rathdrum	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-18	*Silt loam	ML, MH	A-5	0	0	95-100	90-100	80-100	65-90	40-60	NP-5
	18-39	*Silt loam, Very fine sandy loam	MH, ML	A-5	0	0	95-100	90-100	80-100	50-80	40-60	NP-5
	39-61	*Silt loam, Gravelly silt loam, very fine sandy loam	MH, ML, SM, GM	A-5	0-10	0-20	65-95	60-90	50-80	40-70	40-60	NP-5
Bonner	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-6	*Silt loam	GM, ML, SM	A-4	0	0	55-75	50-70	45-70	40-65	30-40	NP-5
	6-22	*Gravelly silt loam, Gravelly loam, silt loam	SM, GM, ML	A-4	0	0-15	60-90	55-85	50-80	40-70	30-40	NP-5
	22-30	*Gravelly loam, Gravelly sandy loam	GM, SM	A-4, A-2	0	0-15	55-80	50-75	40-65	30-50	15-20	NP
	30-60	*Very gravelly loamy sand, Extremely gravelly coarse sand, very gravelly sand	GP, GP-GM, GM	A-1	0	0-30	20-50	15-45	10-30	0-15	0-0	NP

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
129—Kootenai-Bonner complex, 0 to 20 percent slopes												
Kootenai	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-8	*Gravelly silt loam	GM, ML	A-4, A-2	0	0-9	58-74	33-74	29-70	22-56	0-35	NP-6
	8-24	*Gravelly silt loam, Gravelly loam, gravelly sandy loam	GM, SM	A-1, A-2, A-4	0	0-8	58-74	36-74	31-70	25-55	0-29	NP-6
	24-28	*Very gravelly loam, Very gravelly sandy loam	GM, GC-GM	A-1, A-2	0	9-17	56-71	41-71	33-62	21-43	0-24	NP-6
	28-62	*Extremely gravelly coarse sand, Extremely gravelly loamy coarse sand	GP	A-1	0	8-26	20-68	7-68	3-33	1-10	0-19	NP-2
Bonner	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-10	*Gravelly silt loam	ML, SM, GM	A-4, A-2	0	0-13	54-70	29-70	25-66	19-51	0-34	NP-4
	10-20	*Gravelly silt loam, Gravelly loam, silt loam	GM, ML, SM	A-2, A-4	0	0-13	60-86	26-86	23-81	17-63	0-27	NP-4
	20-28	*Gravelly sandy loam, Gravelly loam	SM, GM	A-2, A-4	0	0-11	62-83	38-83	34-80	22-53	0-22	NP-4
	28-62	*Very gravelly loamy sand, Extremely gravelly coarse sand, very gravelly sand	GP, GP-GM, GM	A-1	0	0-18	40-68	13-68	10-55	3-21	0-19	NP-2

Engineering Properties– Kootenai County Area, Idaho

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
130—Kootenai-Rathdrum association, 0 to 20 percent slopes												
Kootenai	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-8	*Gravelly silt loam	GM, ML	A-2, A-4	0	0-9	58-74	33-74	29-70	22-56	0-35	NP-6
	8-24	*Gravelly silt loam, Gravelly loam, gravelly sandy loam	GM, SM	A-1, A-2, A-4	0	0-8	58-74	36-74	31-70	25-55	0-29	NP-6
	24-28	*Very gravelly loam, Very gravelly sandy loam	GC-GM, GM	A-1, A-2	0	9-17	56-71	41-71	33-62	21-43	0-24	NP-6
	28-62	*Extremely gravelly coarse sand, Extremely gravelly loamy coarse sand	GP	A-1	0	8-26	20-68	7-68	3-33	1-10	0-19	NP-2
Rathdrum	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-24	*Silt loam	MH, ML	A-4, A-5	0	0	92-100	75-100	67-93	51-72	0-36	NP-3
	24-46	*Silt loam, Very fine sandy loam	MH, ML	A-4, A-5	0	0	92-100	75-100	67-93	51-72	0-23	NP-3
	46-56	*Very fine sandy loam, Silt loam, fine sandy loam	MH, ML	A-5, A-4	0	0	92-100	77-100	74-100	44-61	0-21	NP-3
	56-62	*Silt loam, Gravelly silt loam, very fine sandy loam	MH, ML, SM, GM	A-4, A-5	0-8	0-14	65-95	30-95	27-89	21-68	0-20	NP-3

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				Pct	Pct					Pct	
145—Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes												
Lenz	0-7	*Loam	SC, CL-ML, ML	A-4	0	0	85-100	62-100	51-93	36-68	22-37	6-13
	7-12	*Loam	CL-ML, ML, SC	A-4	0	0	85-100	62-100	51-93	36-68	22-37	6-13
	12-23	*Very gravelly sandy loam, Very gravelly loam	GC-GM, SC, GM, SC-SM, SM	A-1, A-2, A-4	0-10	0-16	56-85	25-85	18-70	9-39	21-33	6-13
	23-36	*Extremely stony sandy loam, Extremely stony loamy sand	SM, SC-SM	A-4, A-1, A-2	44-86	0	100	100	74-79	36-41	16-23	2-6
	36-46	*Unweathered bedrock	—	—	—	—	—	—	—	—	—	—
Spokane	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-9	*Loam	SM, SC-SM, ML	A-4	0	0-5	80-90	69-90	58-82	40-59	23-35	4-10
	9-28	*Gravelly loam, Gravelly coarse sandy loam, gravelly sandy loam	SM, SC-SM	A-4, A-1, A-2	0	0-11	66-82	50-82	41-75	28-54	18-31	2-10
	28-38	*Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Rock outcrop	0-60	*Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
149—McGuire-Marble association, 0 to 7 percent slopes												
Mcguire	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-9	*Gravelly sandy loam	SM, GM	A-1, A-2	0	0	63-68	50-68	36-57	19-32	0-29	NP-6
	9-23	*Very gravelly sandy loam, Very gravelly coarse sandy loam, very gravelly loam	GM	A-1, A-2	0	0	54-58	42-58	30-48	15-27	0-24	NP-6
	23-27	*Extremely gravelly coarse sandy loam	GM, GP-GM	A-1	0	0-6	20-56	10-56	6-37	3-22	0-19	NP-2
	27-61	*Extremely gravelly coarse sand	GP	A-1	0	0-6	15-46	9-46	4-22	1-7	0-19	NP-2
Marble	0-2	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-3	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	3-9	*Sandy loam	SC-SM, SM	A-2	0	0	94-100	83-100	61-79	30-41	18-29	2-6
	9-63	*Loamy sand, Sand, coarse sand	SM, SP, SP-SM	A-3, A-1, A-2	0	0	91-100	73-100	56-78	19-27	0-14	NP

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
161—Rathdrum silt loam, 0 to 7 percent slopes												
Rathdrum	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-24	*Silt loam	ML, MH	A-4, A-5	0	0	92-100	75-100	67-93	51-72	0-36	NP-3
	24-46	*Silt loam, Very fine sandy loam	MH, ML	A-4, A-5	0	0	92-100	75-100	67-93	51-72	0-23	NP-3
	46-56	*Very fine sandy loam, Silt loam, fine sandy loam	MH, ML	A-4, A-5	0	0	92-100	77-100	74-100	44-61	0-21	NP-3
	56-62	*Silt loam, Gravelly silt loam, very fine sandy loam	GM, MH, ML, SM	A-4, A-5	0	0	69-95	38-95	34-89	26-68	0-20	NP-3
174—Selle fine sandy loam, 0 to 7 percent slopes												
Selle	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-19	*Fine sandy loam	SM	A-4	0	0	100	100	87-89	43-45	0-24	NP-1
	19-26	*Fine sandy loam, Sandy loam	SM	A-2, A-4	0	0	100	100	87-89	43-45	0-19	NP-1
	26-60	*Loamy fine sand, Fine sand, sand	SM, SP-SM	A-2, A-3	0	0	100	100	94-96	33-35	0-18	NP-1

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
184—Spokane loam, 30 to 65 percent slopes												
Spokane	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-9	*Loam	SM, SC-SM, ML	A-4	0	0-5	80-90	69-90	58-82	40-59	23-35	4-10
	9-28	*Gravelly loam, Gravelly coarse sandy loam, gravelly sandy loam	SM, SC-SM	A-1, A-2, A-4	0	0-11	66-82	50-82	41-75	28-54	18-31	2-10
	28-38	*Weathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties– Kootenai County Area, Idaho												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
185—Spokane-Moscow association, 35 to 65 percent slopes												
Spokane	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-9	*Loam	SC-SM, ML, SM	A-4	0	0-5	80-90	69-90	58-82	40-59	23-35	4-10
	9-28	*Gravelly loam, Gravelly coarse sandy loam, gravelly sandy loam	SM, SC-SM	A-2, A-4, A-1	0	0-11	66-82	50-82	41-75	28-54	18-31	2-10
	28-38	*Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Moscow	0-2	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-3	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	3-4	*Loam	ML, CL	A-4	0	0	84-100	69-100	57-96	39-70	22-40	6-16
	4-26	*Loam, Silt loam	ML, SC	A-4	0	0	86-100	55-100	45-96	31-70	22-38	6-16
	26-29	*Gravelly sandy loam, Gravelly coarse sandy loam	SM	A-1, A-2, A-4	0	0-4	84-100	47-98	35-79	18-43	0-22	NP-4
	29-39	*Weathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties– Kootenai County Area, Idaho													
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
198—Vassar silt loam, 5 to 30 percent slopes												
Vassar	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-22	*Silt loam	ML, CL	A-4, A-5	0	0	85-100	62-100	58-100	49-86	23-35	4-10
	22-62	*Coarse sandy loam, Sandy loam, gravelly sandy loam	SM	A-1, A-2, A-4	0	0	72-94	44-94	28-61	16-37	0-19	NP-1
199—Vassar silt loam, 30 to 65 percent slopes												
Vassar	0-1	*Slightly decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	1-2	*Moderately decomposed plant material	PT	A-8	0	0	100	100	60-100	50-90	—	—
	2-22	*Silt loam	ML, CL	A-4, A-5	0	0	85-100	62-100	58-100	49-86	23-35	4-10
	22-62	*Coarse sandy loam, Sandy loam, gravelly sandy loam	SM	A-1, A-2, A-4	0	0	72-94	44-94	28-61	16-37	0-19	NP-1
205—Water												
Water	—	—	—	—	—	—	—	—	—	—	—	—

Physical Soil Properties (Spirit Lake Hydraulic Cond.)

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates in the table are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity (Ksat) is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion.

There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Physical Soil Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
12—Elmira loamy sand, 0 to 8 percent slopes														
Elmira	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	2	134
	1-5	-82-	-16-	0- 2- 4	1.05-1.30	42.00-141.00	0.06-0.11	0.0-2.9	0.5-3.0	.20	.20			
	5-26	-82-	-16-	0- 2- 4	1.05-1.30	42.00-141.00	0.06-0.11	0.0-2.9	0.5-3.0	.20	.20			
	26-60	-82-	-16-	0- 2- 4	1.30-1.50	42.00-141.00	0.04-0.10	0.0-2.9	0.0-1.0	.10	.10			
25—Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes														
Kootenai	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	6	48
	1-6	-34-	-59-	3- 7- 10	0.70-0.95	4.00-14.00	0.15-0.17	0.0-2.9	3.0-6.0	.20	.32			
	6-17	-34-	-59-	3- 7- 10	0.90-1.30	4.00-42.00	0.09-0.16	0.0-2.9	1.0-3.0	.15	.32			
	17-27	-69-	-24-	3- 7- 10	1.30-1.55	4.00-42.00	0.05-0.09	0.0-2.9	0.5-1.0	.10	.32			
	27-60	-91-	- 7-	0- 3- 5	1.40-1.65	141.00	0.03-0.05	0.0-2.9	0.0-0.5	.02	.20			
Bonner	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	6	48
	1-6	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.00	0.14-0.16	0.0-2.9	3.0-6.0	.15	.24			
	6-22	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.00	0.14-0.20	0.0-2.9	1.0-3.0	.20	.37			
	22-30	-49-	-46-	2- 5- 8	1.35-1.55	4.00-42.00	0.08-0.12	0.0-2.9	0.5-1.0	.20	.43			
	30-60	-81-	-16-	0- 3- 5	1.30-1.55	42.00-141.00	0.03-0.05	0.0-2.9	0.0-0.5	.02	.10			

Physical Soil Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
26—Kruse silt loam, 30 to 65 percent slopes														
Kruse	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	5	56
	1-16	-30-	-56-	10-14- 18	1.00-1.20	4.00-14.00	0.19-0.21	0.0-2.9	1.0-3.0	.49	.49			
	16-52	-35-	-38-	20-28- 35	1.35-1.60	1.40-4.00	0.19-0.21	3.0-5.9	0.0-0.5	.37	.43			
	52-60	-64-	-27-	5-10- 15	1.40-1.60	14.00-42.00	0.10-0.15	0.0-2.9	0.0-0.5	.28	.37			
28—Lenz-Rock outcrop association, 30 to 65 percent slopes														
Lenz	0-7	-69-	-24-	5- 8- 10	1.30-1.50	14.00-42.00	0.07-0.09	0.0-2.9	1.0-3.0	.17	.32	2	5	56
	7-24	-69-	-24-	5- 8- 10	1.30-1.50	14.00-42.00	0.04-0.06	0.0-2.9	0.5-1.0	.05	.28			
	24-34	—	—	—	—	—	—	—	—					
Rock outcrop	0-60	—	—	—	—	—	—	—	—					

Physical Soil Properties– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
45—Rathdrum-Bonner silt loams, 0 to 8 percent slopes														
Rathdrum	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	5	56
	1-18	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.00	0.19-0.21	0.0-2.9	4.0-8.0	.28	.28			
	18-39	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.00	0.15-0.21	0.0-2.9	1.0-2.0	.28	.32			
	39-61	-37-	-59-	2- 4- 6	0.85-1.30	4.00-14.00	0.11-0.21	0.0-2.9	0.0-0.5	.24	.32			
Bonner	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-6	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.00	0.14-0.16	0.0-2.9	3.0-6.0	.15	.24			
	6-22	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.00	0.14-0.20	0.0-2.9	1.0-3.0	.20	.37			
	22-30	-49-	-46-	2- 5- 8	1.35-1.55	4.00-42.00	0.08-0.12	0.0-2.9	0.5-1.0	.20	.43			
	30-60	-81-	-16-	0- 3- 5	1.30-1.55	42.00-141.00	0.03-0.05	0.0-2.9	0.0-0.5	.02	.10			

Physical Soil Properties– Kootenai County Area, Idaho

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
129—Kootenai-Bonner complex, 0 to 20 percent slopes														
Kootenai	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	6	48
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-8	-34-	-59-	3- 7- 10	0.70-0.95	4.00-14.11	0.15-0.17	0.0-2.9	3.0-6.0	.20	.32			
	8-24	-34-	-59-	3- 7- 10	0.90-1.30	4.00-42.34	0.09-0.16	0.0-2.9	1.0-3.0	.15	.32			
	24-28	-49-	-42-	3- 9- 10	1.30-1.55	4.00-42.34	0.05-0.09	0.0-2.9	0.5-1.0	.10	.32			
	28-62	-91-	- 7-	0- 3- 5	1.40-1.65	141.14	0.03-0.05	0.0-2.9	0.0-0.5	.02	.20			
Bonner	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	6	48
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-10	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.11	0.14-0.16	0.0-2.9	3.0-6.0	.15	.24			
	10-20	-37-	-58-	2- 5- 8	0.70-0.95	4.00-14.11	0.14-0.20	0.0-2.9	1.0-3.0	.20	.37			
	20-28	-49-	-46-	2- 5- 8	1.35-1.55	4.00-42.34	0.08-0.12	0.0-2.9	0.5-1.0	.20	.43			
	28-62	-81-	-16-	0- 3- 5	1.30-1.55	42.34-141.14	0.03-0.05	0.0-2.9	0.0-0.5	.02	.10			

Physical Soil Properties– Kootenai County Area, Idaho

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
130—Kootenai-Rathdrum association, 0 to 20 percent slopes														
Kootenai	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	6	48
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-8	-34-	-59-	3- 7- 10	0.70-0.95	4.00-14.11	0.15-0.17	0.0-2.9	3.0-6.0	.20	.32			
	8-24	-34-	-59-	3- 7- 10	0.90-1.30	4.00-42.34	0.09-0.16	0.0-2.9	1.0-3.0	.15	.32			
	24-28	-49-	-42-	3- 9- 10	1.30-1.55	4.00-42.34	0.05-0.09	0.0-2.9	0.5-1.0	.10	.32			
	28-62	-91-	- 7-	0- 3- 5	1.40-1.65	141.14	0.03-0.05	0.0-2.9	0.0-0.5	.02	.20			
Rathdrum	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	5	56
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-24	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.11	0.19-0.21	0.0-2.9	4.0-8.0	.28	.28			
	24-46	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.11	0.15-0.21	0.0-2.9	1.0-2.0	.28	.32			
	46-56	-62-	-34-	2- 4- 6	0.65-1.10	4.00-14.11	0.15-0.21	0.0-2.9	0.5-1.0	.28	.32			
	56-62	-37-	-59-	2- 4- 6	0.85-1.30	4.00-14.11	0.11-0.21	0.0-2.9	0.0-0.5	.24	.32			

Physical Soil Properties– Kootenai County Area, Idaho														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
145—Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes														
Lenz	0-7	-44-	-41-	10-15- 20	1.20-1.40	4.00-14.11	0.14-0.17	0.0-2.9	1.0-3.0	.28	.32	2	5	56
	7-12	-44-	-41-	10-15- 20	1.20-1.40	4.00-14.11	0.14-0.17	0.0-2.9	1.0-3.0	.28	.32			
	12-23	-64-	-21-	10-15- 20	1.35-1.55	14.11-42.34	0.05-0.07	0.0-2.9	0.5-1.0	.15	.28			
	23-36	-69-	-24-	5- 8- 10	1.45-1.55	42.34-141.14	0.03-0.07	0.0-2.9	0.0-0.5	.05	.28			
	36-46	—	—	—	—	—	—	—	—					
Spokane	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-9	-45-	-43-	8-12- 15	1.15-1.35	4.00-14.11	0.14-0.18	0.0-2.9	2.0-4.0	.28	.32			
	9-28	-46-	-44-	5-10- 15	1.45-1.75	14.11-42.34	0.07-0.11	0.0-2.9	1.0-2.0	.15	.28			
	28-38	—	—	—	—	0.42-42.34	—	—	—					
Rock outcrop	0-60	—	—	—	—	—	—	—	—					

Physical Soil Properties– Kootenai County Area, Idaho

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
149—McGuire-Marble association, 0 to 7 percent slopes														
Mcguire	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	5	56
	1-9	-64-	-31-	0- 5- 10	1.35-1.50	14.11-42.34	0.07-0.09	0.0-2.9	1.0-3.0	.17	.32			
	9-23	-65-	-30-	0- 5- 10	1.35-1.55	14.11-42.34	0.05-0.07	0.0-2.9	0.5-1.0	.15	.32			
	23-27	-67-	-30-	0- 3- 5	1.45-1.55	14.11-42.34	0.03-0.06	0.0-2.9	0.0-0.5	.05	.28			
	27-61	-91-	- 7-	0- 3- 5	1.50-1.60	141.14	0.03-0.05	0.0-2.9	0.0-0.5	.02	.15			
Marble	0-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	3	86
	2-3	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	3-9	-69-	-24-	5- 8- 10	1.15-1.35	14.11-42.34	0.11-0.13	0.0-2.9	1.0-3.0	.24	.24			
	9-63	-82-	-17-	0- 1- 2	1.40-1.60	42.34-141.14	0.05-0.08	0.0-2.9	0.0-1.0	.10	.10			
161—Rathdrum silt loam, 0 to 7 percent slopes														
Rathdrum	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			5	5	56
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-24	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.11	0.19-0.21	0.0-2.9	4.0-8.0	.28	.28			
	24-46	-37-	-59-	2- 4- 6	0.65-0.90	4.00-14.11	0.15-0.21	0.0-2.9	1.0-2.0	.28	.32			
	46-56	-62-	-34-	2- 4- 6	0.65-1.10	4.00-14.11	0.15-0.21	0.0-2.9	0.5-1.0	.28	.32			
	56-62	-37-	-59-	2- 4- 6	0.85-1.30	4.00-14.11	0.11-0.21	0.0-2.9	0.0-0.5	.24	.32			

Physical Soil Properties– Kootenai County Area, Idaho

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
174—Selle fine sandy loam, 0 to 7 percent slopes														
Selle	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	3	86
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-19	-66-	-31-	2- 3- 4	1.00-1.30	14.11-42.34	0.13-0.15	0.0-2.9	1.0-3.0	.28	.28			
	19-26	-66-	-31-	2- 3- 4	1.30-1.50	14.11-42.34	0.11-0.15	0.0-2.9	0.0-1.0	.32	.32			
	26-60	-80-	-17-	2- 3- 4	1.30-1.60	42.34-141.14	0.05-0.10	0.0-2.9	0.0-0.5	.20	.20			
184—Spokane loam, 30 to 65 percent slopes														
Spokane	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-9	-45-	-43-	8-12- 15	1.15-1.35	4.00-14.11	0.14-0.18	0.0-2.9	2.0-4.0	.28	.32			
	9-28	-46-	-44-	5-10- 15	1.45-1.75	14.11-42.34	0.07-0.11	0.0-2.9	1.0-2.0	.15	.28			
	28-38	—	—	—	—	0.42-42.34	—	—	—					

Physical Soil Properties– Kootenai County Area, Idaho

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
185—Spokane-Moscow association, 35 to 65 percent slopes														
Spokane	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-9	-45-	-43-	8-12- 15	1.15-1.35	4.00-14.11	0.14-0.18	0.0-2.9	2.0-4.0	.28	.32			
	9-28	-46-	-44-	5-10- 15	1.45-1.75	14.11-42.34	0.07-0.11	0.0-2.9	1.0-2.0	.15	.28			
	28-38	—	—	—	—	0.42-42.34	—	—	—					
Moscow	0-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	2-3	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	3-4	-46-	-39-	10-15- 24	0.65-0.95	4.00-14.11	0.16-0.20	0.0-2.9	1.0-3.0	.37	.37			
	4-26	-46-	-39-	10-15- 24	0.65-0.95	4.00-14.11	0.16-0.20	0.0-2.9	1.0-2.0	.32	.37			
	26-29	-66-	-29-	2- 5- 8	1.35-1.55	14.11-42.34	0.12-0.16	0.0-2.9	0.5-1.0	.17	.28			
	29-39	—	—	—	—	0.42-42.34	—	—	—					
198—Vassar silt loam, 5 to 30 percent slopes														
Vassar	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-22	-24-	-63-	8-13- 15	0.65-0.85	4.00-14.11	0.19-0.21	0.0-2.9	2.0-4.0	.32	.32			
	22-62	-67-	-30-	2- 3- 4	1.30-1.50	14.11-42.34	0.07-0.13	0.0-2.9	0.5-1.0	.20	.32			

Physical Soil Properties– Kootenai County Area, Idaho														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
199—Vassar silt loam, 30 to 65 percent slopes														
Vassar	0-1	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0			3	5	56
	1-2	-35-	-50-	0-15- 25	0.10-0.30	42.00-705.00	0.30-0.60	—	60.0-95.0					
	2-22	-24-	-63-	8-13- 15	0.65-0.85	4.00-14.11	0.19-0.21	0.0-2.9	2.0-4.0	.32	.32			
	22-62	-67-	-30-	2- 3- 4	1.30-1.50	14.11-42.34	0.07-0.13	0.0-2.9	0.5-1.0	.20	.32			
205—Water														
Water	—	—	—	—	—	—	—	—	—					

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Water Features (Spirit Lake Runoff Potential)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Water Features– Bonner County Area, Idaho, Parts of Bonner and Boundary Counties										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
12—Elmira loamy sand, 0 to 8 percent slopes										
Elmira	A	Very low	Jan-Dec	—	—	—	—	None	—	—
25—Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes										
Kootenai	B	Medium	Jan-Dec	—	—	—	—	None	—	—
Bonner	B	Low	Jan-Dec	—	—	—	—	None	—	—
26—Kruse silt loam, 30 to 65 percent slopes										
Kruse	B	High	Jan-Dec	—	—	—	—	None	—	—
28—Lenz-Rock outcrop association, 30 to 65 percent slopes										
Lenz	C	Medium	Jan-Dec	—	—	—	—	None	—	—
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	—
45—Rathdrum-Bonner silt loams, 0 to 8 percent slopes										
Rathdrum	B	Low	Jan-Dec	—	—	—	—	None	—	—
Bonner	B	Low	Jan-Dec	—	—	—	—	None	—	—

Water Features– Kootenai County Area, Idaho										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
129—Kootenai-Bonner complex, 0 to 20 percent slopes										
Kootenai	B	Medium	Jan-Dec	—	—	—	—	None	—	—
Bonner	B	Low	Jan-Dec	—	—	—	—	None	—	—
130—Kootenai-Rathdrum association, 0 to 20 percent slopes										
Kootenai	B	Medium	Jan-Dec	—	—	—	—	None	—	—
Rathdrum	B	Low	Jan-Dec	—	—	—	—	None	—	—
145—Lenz-Spokane-Rock outcrop association, 30 to 55 percent slopes										
Lenz	C	High	Jan-Dec	—	—	—	—	None	—	—
Spokane	C	High	Jan-Dec	—	—	—	—	None	—	—
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	—
149—McGuire-Marble association, 0 to 7 percent slopes										
Mcguire	B	Very low	Jan-Dec	—	—	—	—	None	—	—
Marble	A	Very low	Jan-Dec	—	—	—	—	None	—	—
161—Rathdrum silt loam, 0 to 7 percent slopes										
Rathdrum	B	Low	Jan-Dec	—	—	—	—	None	—	—
174—Selle fine sandy loam, 0 to 7 percent slopes										
Selle	B	Very low	Jan-Dec	—	—	—	—	None	—	—

Water Features– Kootenai County Area, Idaho										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
184—Spokane loam, 30 to 65 percent slopes										
Spokane	C	High	Jan-Dec	—	—	—	—	None	—	—
185—Spokane-Moscow association, 35 to 65 percent slopes										
Spokane	C	High	Jan-Dec	—	—	—	—	None	—	—
Moscow	C	High	Jan-Dec	—	—	—	—	None	—	—
198—Vassar silt loam, 5 to 30 percent slopes										
Vassar	B	Medium	Jan-Dec	—	—	—	—	None	—	—
199—Vassar silt loam, 30 to 65 percent slopes										
Vassar	B	High	Jan-Dec	—	—	—	—	None	—	—
205—Water										
Water	—	—	Jan-Dec	—	—	—	—	None	—	—

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Appendix B-2

NRCS Project Area Survey Report
Wastewater Treatment Plant Site

James A. Sewell & Associates, LLC

United States
Department of
Agriculture

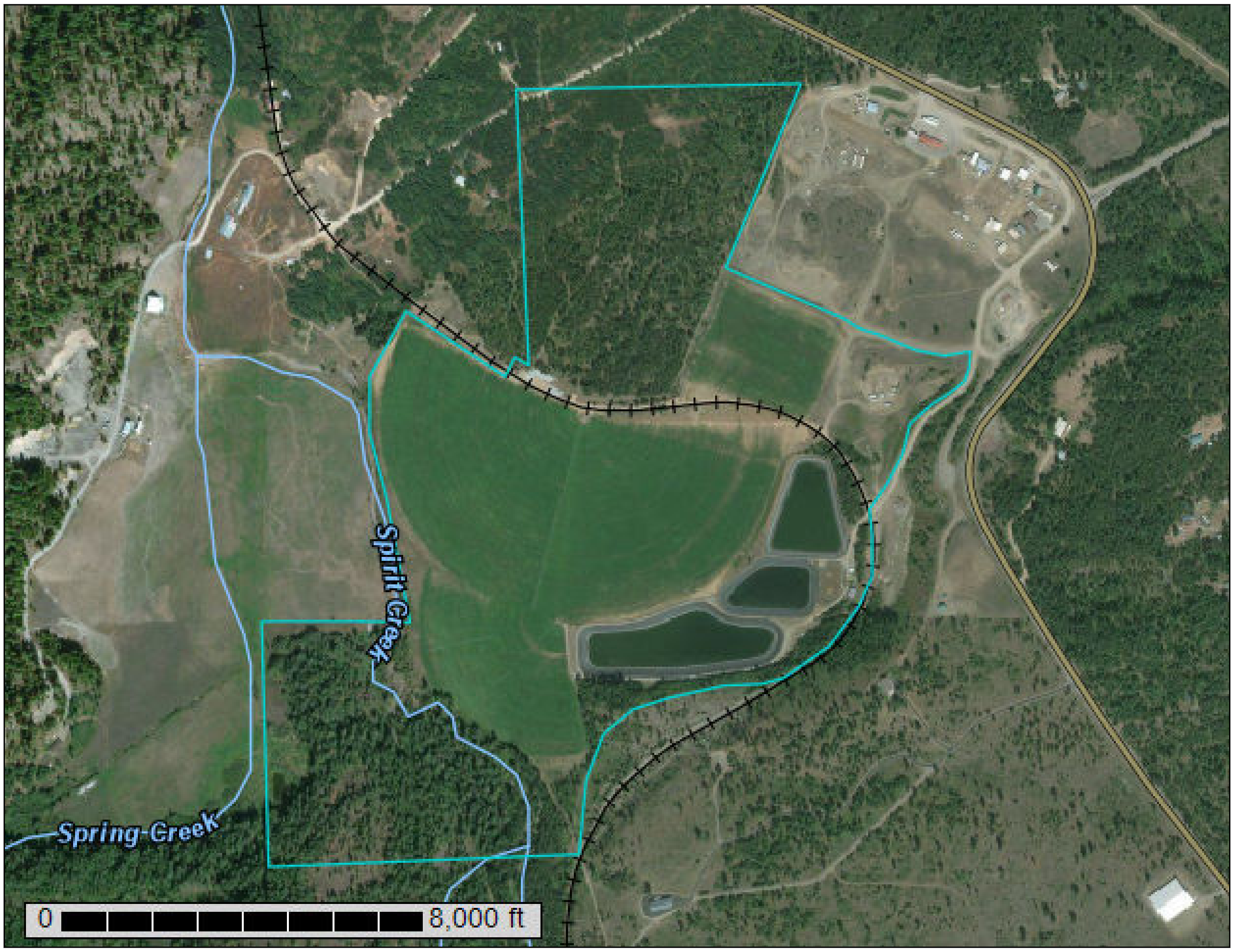
NRCS

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

Spirit Lake WWTP Site



January 19, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

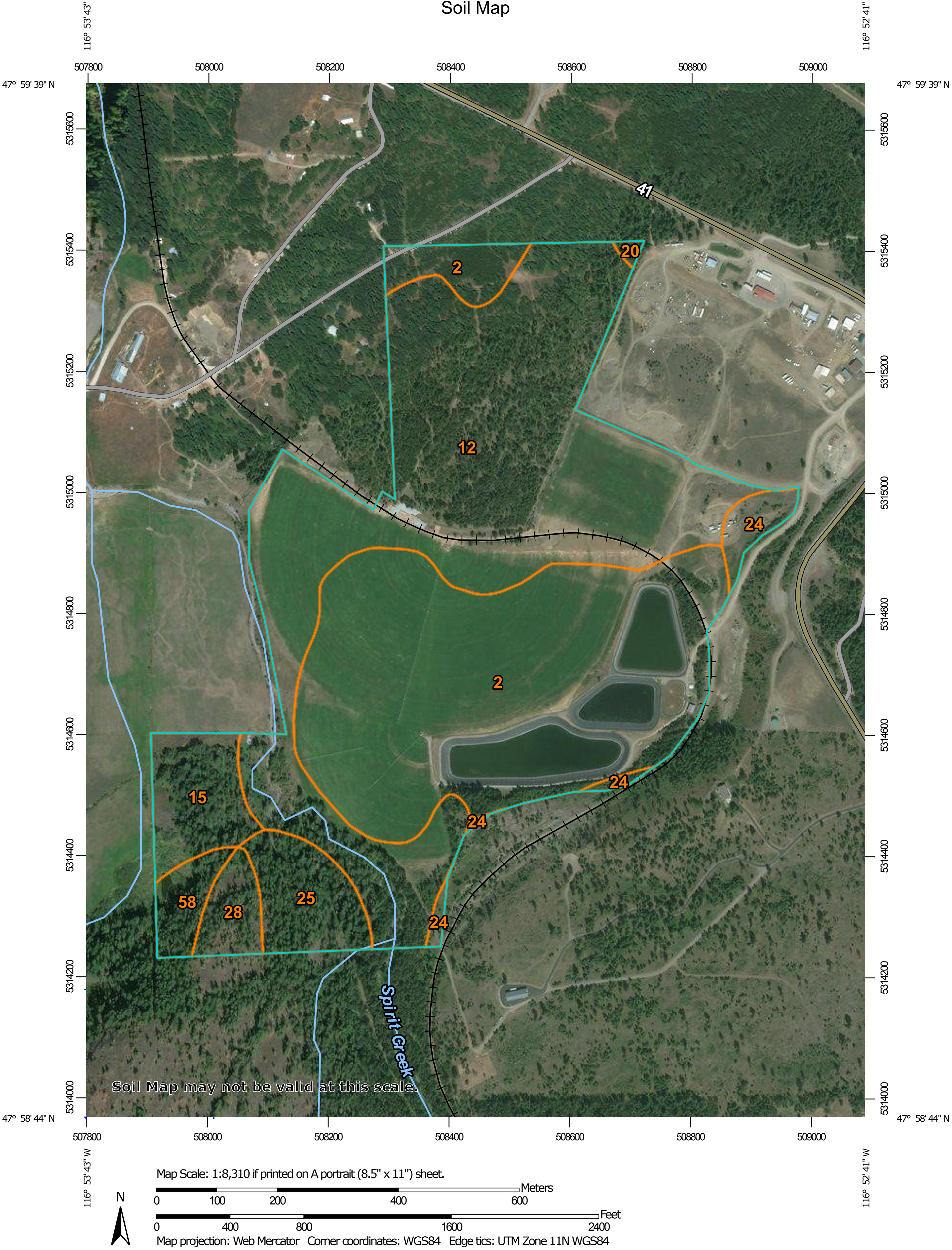
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:8,310 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

☐ Area of Interest (AOI)

Soils

☐ Soil Map Unit Polygons

Soil Map Unit Lines

■ Soil Map Unit Points

Special Point Features

Blowout

☒ Borrow Pit

Clay Spot

◇ Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

+ Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

△ Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 12, Sep 9, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 7, 2013—Nov 4, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2	Bonner gravelly silt loam, 0 to 4 percent slopes	67.7	39.4%
12	Elmira loamy sand, 0 to 8 percent slopes	78.2	45.5%
15	Hoodoo silt loam, 0 to 1 percent slopes	7.9	4.6%
20	Kaniksu sandy loam, 0 to 4 percent slopes	0.3	0.2%
24	Kootenai gravelly silt loam, 20 to 55 percent slopes	3.3	1.9%
25	Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes	7.5	4.4%
28	Lenz-Rock outcrop association, 30 to 65 percent slopes	3.5	2.1%
58	Vassar ashy silt loam, 30 to 65 percent slopes	3.3	1.9%
Totals for Area of Interest		**171.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

2—Bonner gravelly silt loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 545n
Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Bonner and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bonner

Setting

Landform: Outwash terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or schist and/or gneiss

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: gravelly ashy silt loam
Bw - 6 to 22 inches: gravelly silt loam
2BC - 22 to 30 inches: gravelly loam
3C - 30 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

12—Elmira loamy sand, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 545d
Elevation: 200 to 2,700 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 110 to 140 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Elmira and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elmira

Setting

Landform: Dunes, terraces
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Volcanic ash and loess over sandy glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: loamy sand
Bw - 5 to 26 inches: loamy sand
E&Bt - 26 to 60 inches: loamy sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Other vegetative classification: Douglas-fir/common snowberry (CN310)
Hydric soil rating: No

15—Hoodoo silt loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 545h
Elevation: 2,000 to 4,200 feet
Mean annual precipitation: 25 to 45 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 60 to 120 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Hoodoo and similar soils: 70 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hoodoo

Setting

Landform: Drainageways, flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or mixed alluvium

Typical profile

A - 0 to 15 inches: ashy silt loam
Cg1 - 15 to 52 inches: silt loam
2Cg2 - 52 to 60 inches: very cobbly silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 40 to 60 inches to abrupt textural change
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: WET MEADOW 16-24 PZ (R044XY601WA)
Hydric soil rating: Yes

Minor Components

Pywell

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Capehorn

Percent of map unit: 5 percent
Landform: Flood plains
Other vegetative classification: western redcedar/ladyfern (CN540)
Hydric soil rating: Yes

Wrencoe

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Hoodoo, peat substratum

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

20—Kaniksu sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 545p
Elevation: 2,100 to 2,600 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 110 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kaniksu and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kaniksu

Setting

Landform: Outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over outwash derived from granite and/or gneiss and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 8 inches: ashy sandy loam
E&Bt1 - 8 to 20 inches: sandy loam
E&Bt2 - 20 to 60 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Other vegetative classification: Douglas-fir/common snowberry (CN310)
Hydric soil rating: No

24—Kootenai gravelly silt loam, 20 to 55 percent slopes

Map Unit Setting

National map unit symbol: 545t
Elevation: 2,100 to 2,700 feet
Mean annual precipitation: 25 to 30 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Kootenai and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kootenai

Setting

Landform: Escarpments, outwash terraces
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or gneiss and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: gravelly silt loam
Bw - 6 to 17 inches: gravelly silt loam
Bt - 17 to 27 inches: very gravelly sandy loam
2C - 27 to 60 inches: extremely gravelly loamy coarse sand

Properties and qualities

Slope: 20 to 55 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: Douglas-fir/common snowberry (CN310)
Hydric soil rating: No

25—Kootenai-Bonner gravelly silt loams, 0 to 20 percent slopes

Map Unit Setting

National map unit symbol: 545v
Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kootenai and similar soils: 50 percent
Bonner and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kootenai

Setting

Landform: Outwash terraces, moraines
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or gneiss and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: gravelly silt loam
Bw - 6 to 17 inches: gravelly silt loam
Bt - 17 to 27 inches: very gravelly sandy loam
2C - 27 to 60 inches: extremely gravelly loamy coarse sand

Properties and qualities

Slope: 0 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Other vegetative classification: Douglas-fir/common snowberry (CN310)
Hydric soil rating: No

Description of Bonner

Setting

Landform: Moraines, outwash terraces
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash derived from granite and/or schist and/or gneiss

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: gravelly ashy silt loam
Bw - 6 to 22 inches: gravelly silt loam
2BC - 22 to 30 inches: gravelly loam
3C - 30 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

28—Lenz-Rock outcrop association, 30 to 65 percent slopes

Map Unit Setting

National map unit symbol: 545y
Elevation: 2,500 to 4,000 feet
Mean annual precipitation: 25 to 35 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Lenz, stony surface, and similar soils: 45 percent
Rock outcrop: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenz, Stony Surface

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over bedrock derived from granite and/or gneiss and/or schist

Typical profile

A - 0 to 7 inches: gravelly sandy loam
Bw - 7 to 24 inches: very gravelly sandy loam
R - 24 to 34 inches: bedrock

Properties and qualities

Slope: 30 to 65 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: Douglas-fir/ninebark (CN260)
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: bedrock

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Unranked

58—Vassar ashy silt loam, 30 to 65 percent slopes

Map Unit Setting

National map unit symbol: 2tcsg
Elevation: 2,280 to 4,670 feet
Mean annual precipitation: 29 to 49 inches
Mean annual air temperature: 38 to 45 degrees F
Frost-free period: 50 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Vassar and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Vassar

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and loess over residuum weathered from granite and gneiss

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: ashy silt loam
Bw1 - 6 to 19 inches: ashy silt loam
2Bw2 - 19 to 29 inches: gravelly sandy loam
2C - 29 to 53 inches: gravelly sandy loam
2Cr - 53 to 59 inches: bedrock

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 39 to 59 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

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Appendix B-3
Flood Maps

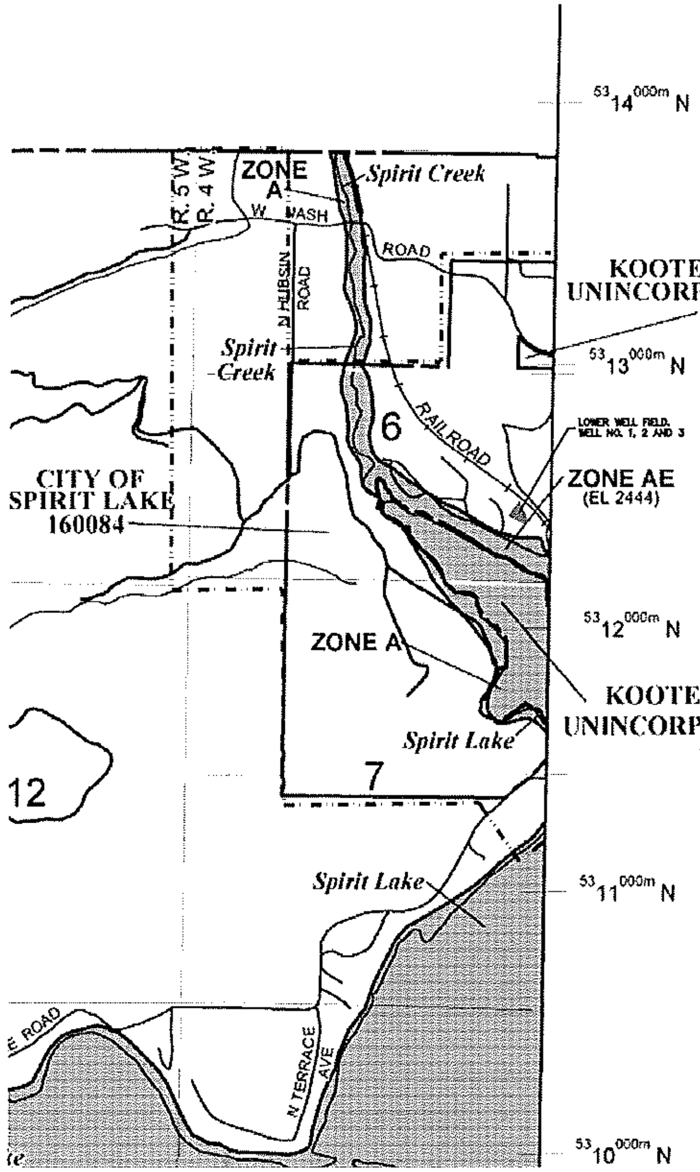
FEMA Flood Map for City of Spirit Lake

James A. Sewell & Associates, LLC

NOTE:
THE PROPOSED PROJECT PLANNING AREA AND THE AREA OF POTENTIAL EFFECT COINCIDE AT ALL LOCATIONS.

LINETYPE LEGEND

- - - PROPOSED PROJECT PLANNING AREA AND AREA OF POTENTIAL EFFECT



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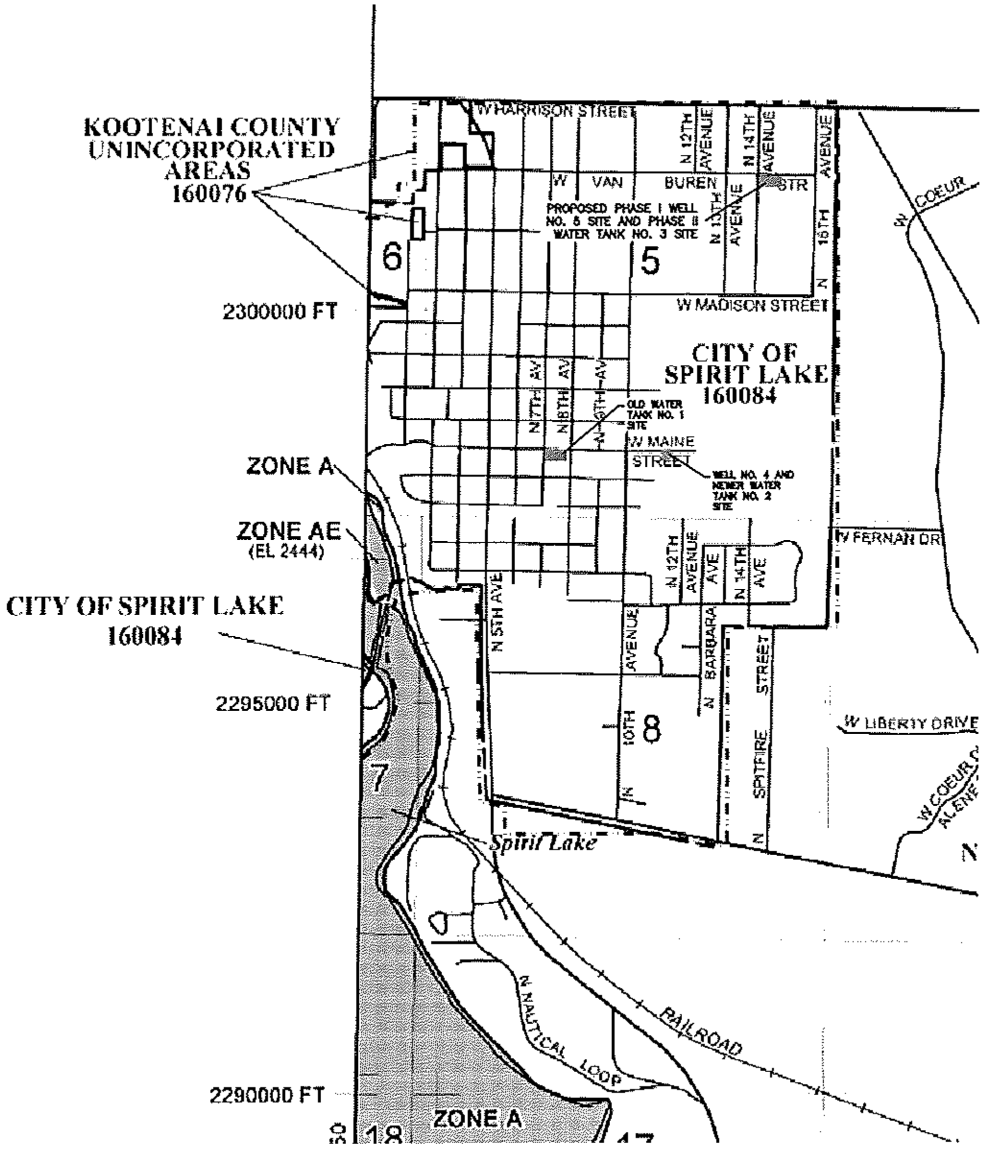


MAP NO. 16055C0075E
SCALE: NOT TO SCALE

LEGEND

▨ SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); No Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▨ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

N
SCALE: NTS

4.1 **CITY OF SPIRIT LAKE FEMA MAP**

ENGINEER'S STAMP

No.	DATE	REVISION	DRN/CHK'D

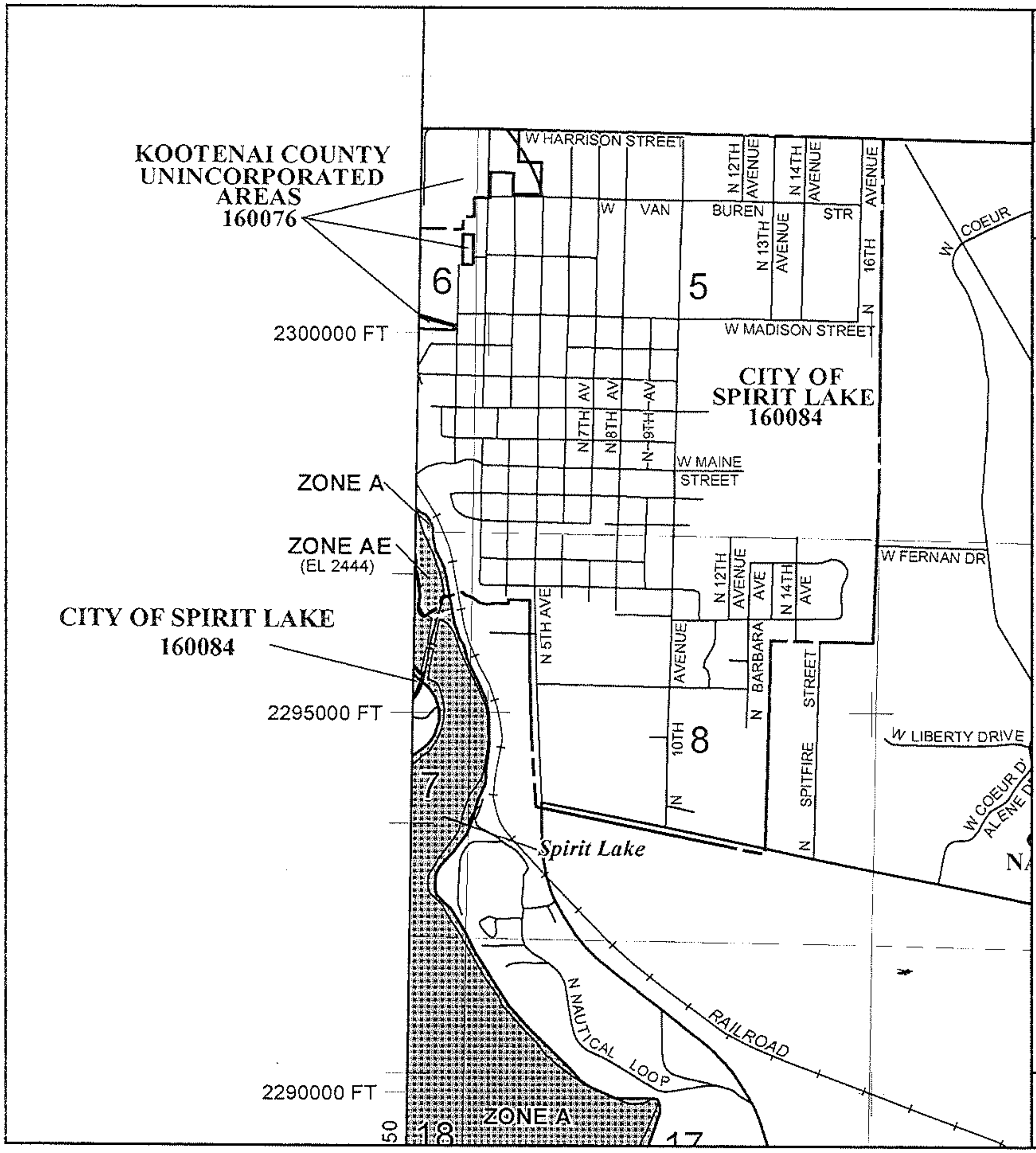
James A. Sewell and Associates, LLC
CONSULTING ENGINEERS
NEWPORT, WASHINGTON, 99156
(509) 447-3626

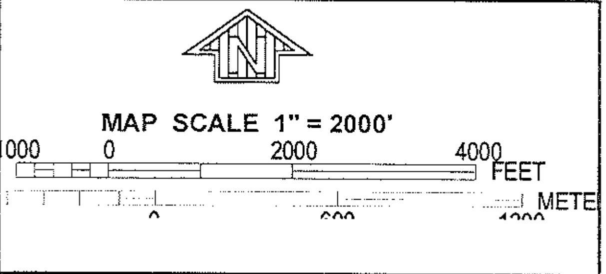
SHEET TITLE: CITY OF SPIRIT LAKE FEMA FIRMETTE MAP

PROJECT: CITY OF SPIRIT LAKE WATER SYSTEM IMPROVEMENTS

DATE:	7-31-2012
SCALE:	AS SHOWN
DRAWN BY:	SJF
DESIGNED BY:	SJF
CHECKED BY:	EJE
FILE No.:	WATER SYSTEM OVERALL PLAN SF.DWG
DATA No.:	18091-05-033

SHEET 1 OF 1





PANEL 0075E

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

FIRM

FLOOD INSURANCE RATE MAP

KOOTENAI COUNTY, IDAHO

AND INCORPORATED AREAS

PANEL 75 OF 975

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KOOTENAI COUNTY	160076	0075	E
SPIRIT LAKE, CITY OF	160084	0075	E

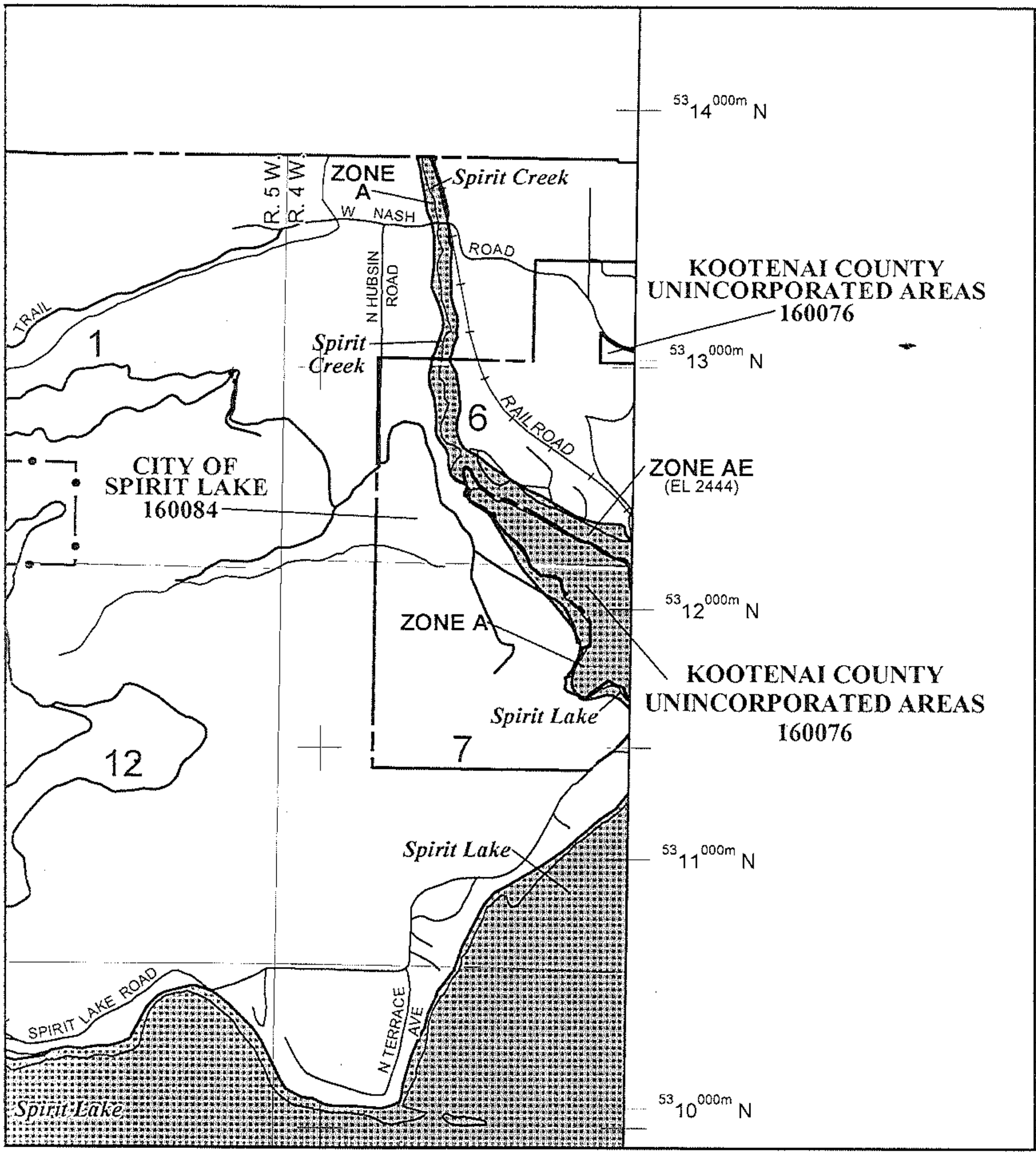
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
16055C0075E

EFFECTIVE DATE
MAY 3, 2010

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 2000'

PANEL 0050E

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

FIRM
FLOOD INSURANCE RATE MAP
KOOTENAI COUNTY, IDAHO
AND INCORPORATED AREAS

PANEL 50 OF 975
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KOOTENAI COUNTY	160076	0050	E
SPIRIT LAKE, CITY OF	160084	0050	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
16055C0050E

EFFECTIVE DATE
MAY 3, 2010

Federal Emergency Management Agency

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LEGEND

▨ SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

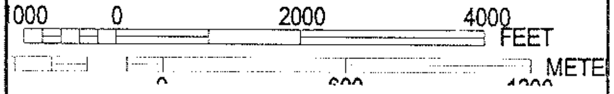
░ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

MAP SCALE 1" = 2000'



NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 0075E

FIRM
FLOOD INSURANCE RATE MAP
KOOTENAI COUNTY, IDAHO
AND INCORPORATED AREAS

PANEL 75 OF 975
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KOOTENAI COUNTY	160076	0075	E
SPIRIT LAKE, CITY OF	160084	0075	E

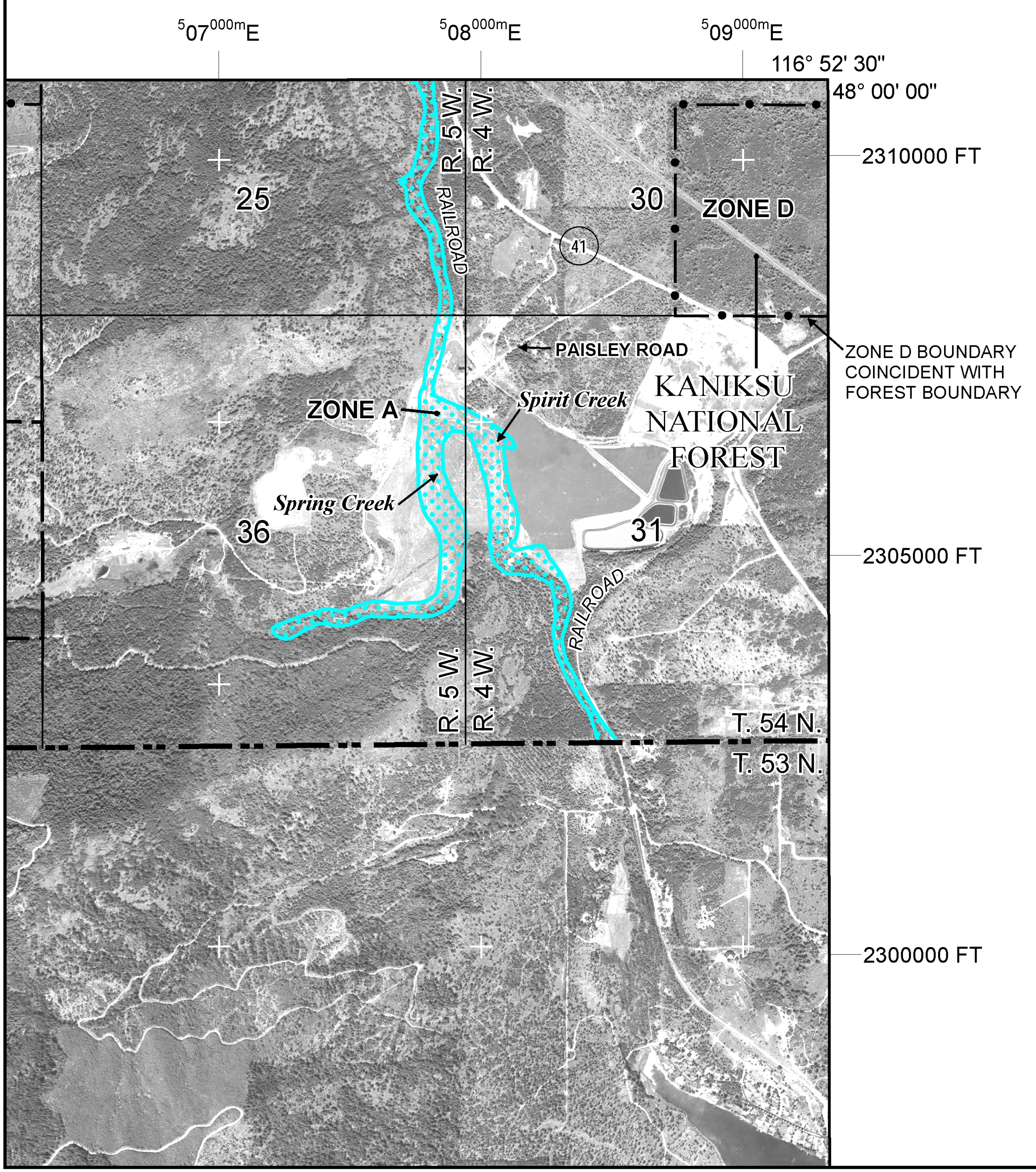
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
16055C0075E

EFFECTIVE DATE
MAY 3, 2010

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



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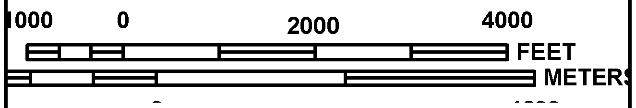


NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 1325E

FIRM

FLOOD INSURANCE RATE MAP

BONNER COUNTY, IDAHO

AND INCORPORATED AREAS

PANEL 1325 OF 1475

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BONNER COUNTY	160206	1325	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
16017C1325E

EFFECTIVE DATE
NOVEMBER 18, 2009

Federal Emergency Management Agency

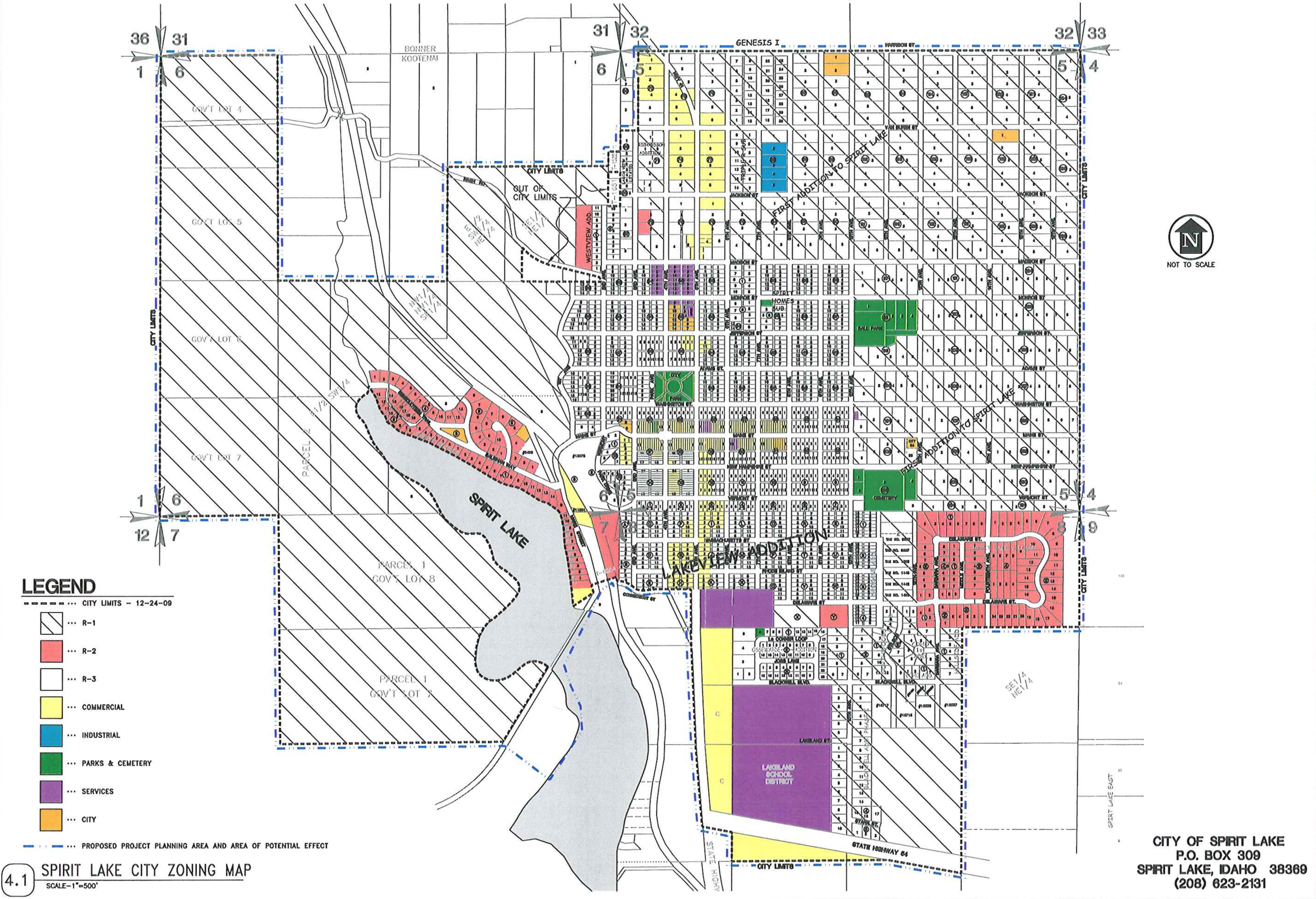
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix B-4
Land Use Maps

City of Spirit Lake Zoning Map, Kootenai County Land Use Map, City of Spirit Lake Land Use Map

James A. Sewell & Associates, LLC

TOWNSHIP 53 NORTH RANGE 4 WEST, B.M. KOOTENAI COUNTY, IDAHO



LEGEND

- ▬ ▬ ▬ ··· CITY LIMITS – 12-24-09
- ▨ ··· R-1
- 🟥 ··· R-2
- ☐ ··· R-3
- 🟨 ··· COMMERCIAL
- 🟦 ··· INDUSTRIAL
- 🟩 ··· PARKS & CEMETERY
- 🟪 ··· SERVICES
- 🟧 ··· CITY
- ▬ · · ▬ ··· PROPOSED PROJECT PLANNING AREA AND AREA OF POTENTIAL EFFECT

4.1 SPIRIT LAKE CITY ZONING MAP

SCALE–1"=500'

CITY OF SPIRIT LAKE
P.O. BOX 309
SPIRIT LAKE, IDAHO 38369
(208) 623-2131

ENGINEER'S STAMP

No.	DATE	REVISION	DRN/CHK'D
1	7-24-12	UPDATED ZONING MAP	JMB/EJE

James A. Sewell and Associates, LLC
CONSULTING ENGINEERS
NEWPORT, WASHINGTON, 99156
(509) 447-3626

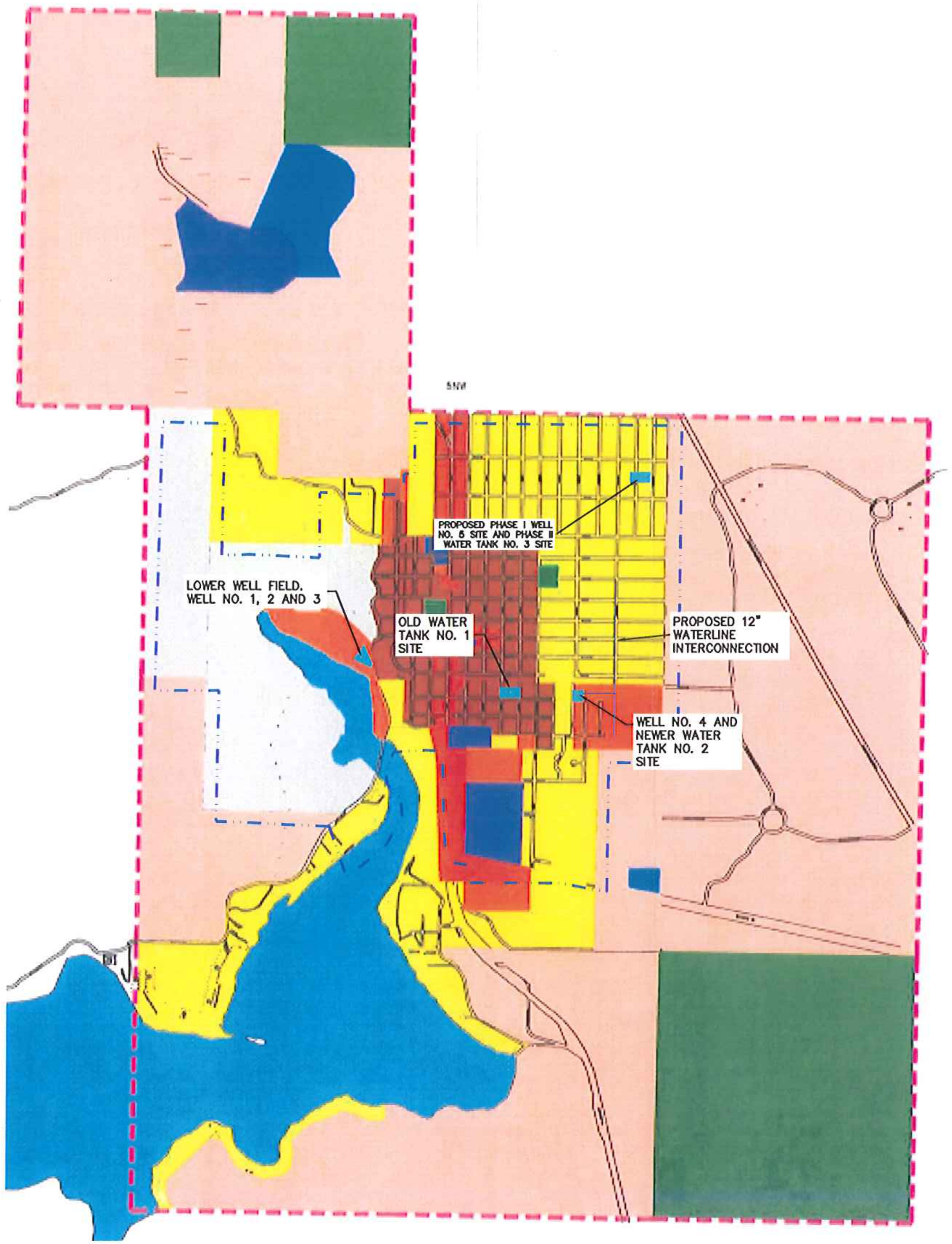
SHEET TITLE: ZONING MAP

PROJECT: CITY OF SPIRIT LAKE
KOOTENAI COUNTY, IDAHO

DATE: 1-14-10
SCALE: NONE
DRAWN BY: JMB
CHECKED BY: EJE
FILE No.:
FILE Nm.: SPL-OVERALL MAPS

SHEET 1 OF 1

NOTE:
THE PROPOSED PROJECT PLANNING AREA AND THE AREA OF POTENTIAL EFFECT COINCIDE AT ALL LOCATIONS.



LEGEND

— — — —	AREA OF CITY IMPACT
— · —	SPIRIT LAKE CITY LIMITS
▨	VERY LOW DENSITY (0 - 0.5 DU/ACRE)
🟨	LOW DENSITY (0.5 - 3.0 DU/ACRE)
🟧	MEDIUM DENSITY (3.1 - 5.0 DU/ACRE)
🟫	HIGH DENSITY (5.0 - 10 DU/ACRE)
🟥	COMMERCIAL
🟦	INDUSTRIAL
🟦	PUBLIC/COMMUNITY
⬜	PLANNED AREA
🟩	PARKS
🟩	PUBLIC MANAGED LAND
— · · — · · —	PROPOSED PROJECT PLANNING AREA AND AREA OF POTENTIAL EFFECT

NOT TO SCALE

N
SCALE: NTS

4.1 CITY OF SPIRIT LAKE LAND USE MAP

ENGINEER'S STAMP		
No.	DATE	REVISION	DRN/CHK'D

James A. Sewell and Associates, LLC
CONSULTING ENGINEERS
NEWPORT, WASHINGTON, 99156
(509) 447-3626

SHEET TITLE: CITY OF SPIRIT LAKE LAND USE MAP

PROJECT: CITY OF SPIRIT LAKE WATER SYSTEM IMPROVEMENTS

DATE: 7-31-2012
SCALE: AS SHOWN
DRAWN BY: SJF
DESIGNED BY: SJF
CHECKED BY: EJE
FILE No.: WATER SYSTEM OVERALL PLAN SF.DWG
DATA No.: 19091-05-033

SHEET 1 OF 1

FUTURE LAND USE MAP

CITY OF SPIRIT LAKE

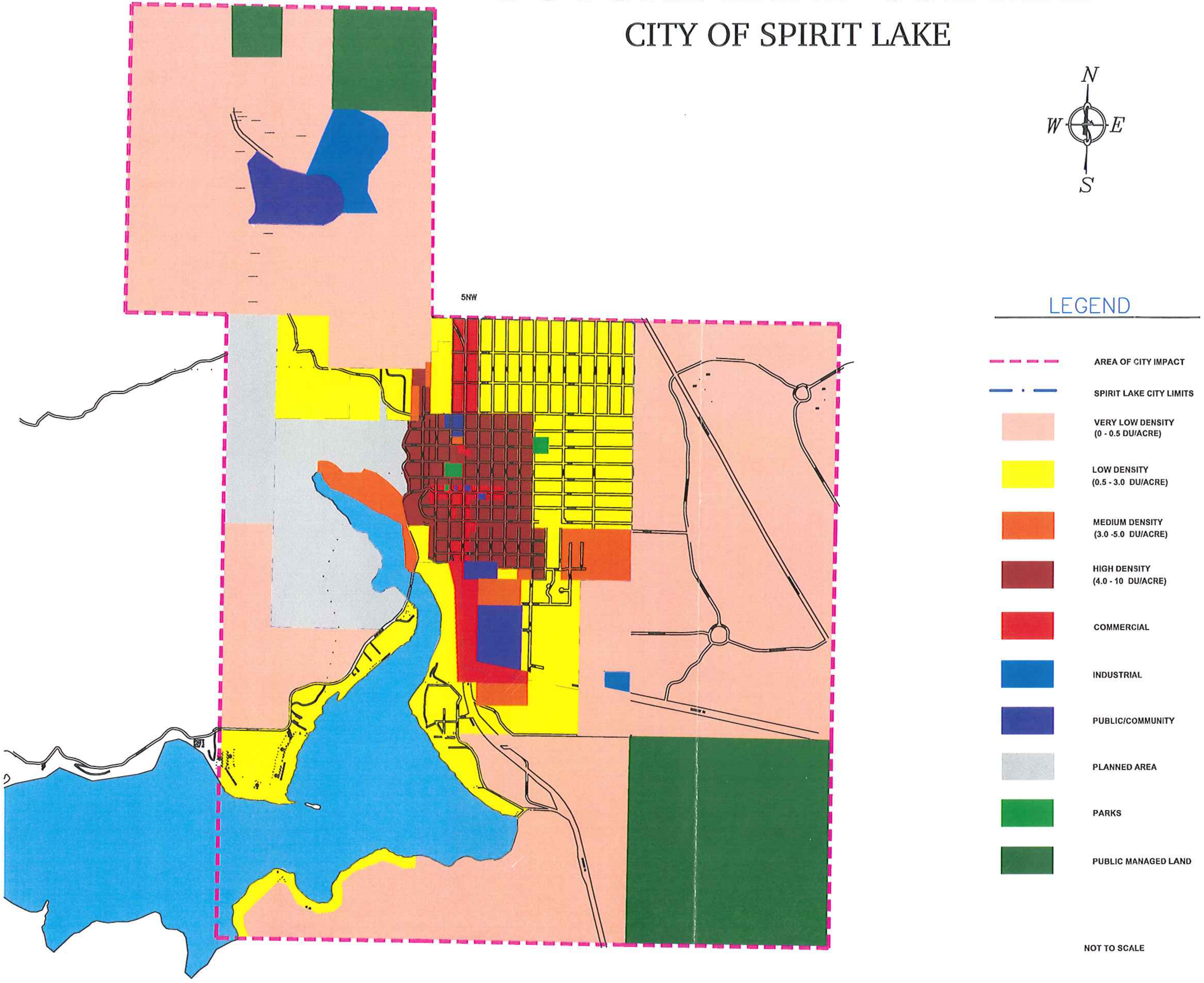
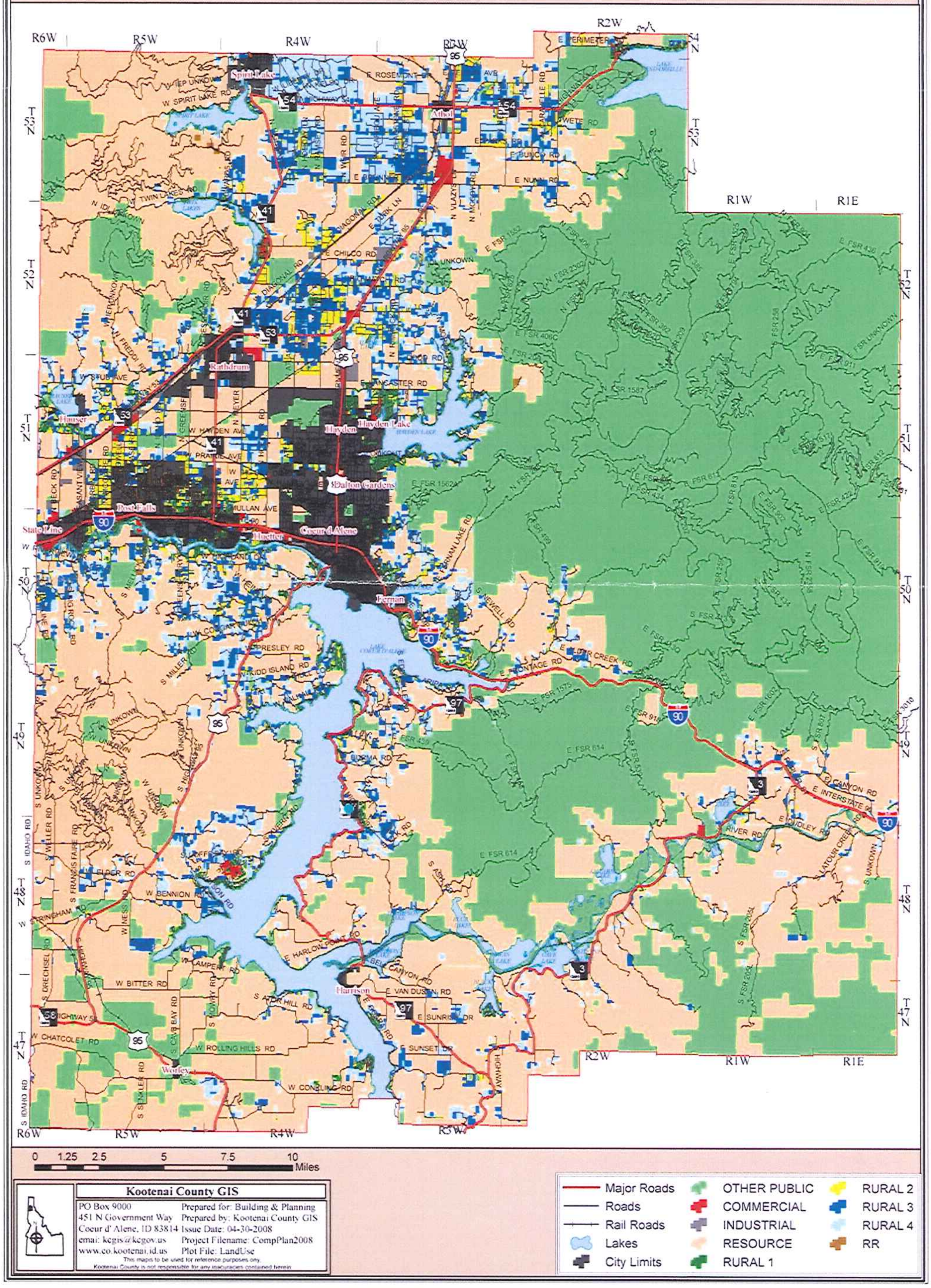


FIG. 9-1

Kootenai County Comprehensive Plan 2008
Existing Land Use



Kootenai County GIS

PO Box 9000
451 N Government Way
Coeur d' Alene, ID 83814
emai: kcgis@kcgov.us
www.co.kootenai.id.us

Prepared for: Building & Planning
Prepared by: Kootenai County GIS
Issue Date: 04-30-2008
Project Filename: CompPlan2008
Plot File: LandUse

This maps to be used for reference purposes ony.
Kootenai County is not responsible for any inacuracies contained herein.

Appendix B-5

Western Regional Climate Center
Bayview, Idaho Model Basin
Annual Climate Data

James A. Sewell & Associates, LLC

BAYVIEW MODEL BASIN, IDAHO (100667)

Period of Record Monthly Climate Summary

Period of Record : 04/01/1947 to 06/10/2016

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	34.8	38.9	45.5	54.5	64.0	71.3	79.9	79.1	68.9	55.3	42.8	35.9	55.9
Average Min. Temperature (F)	21.3	23.8	27.0	32.2	38.3	44.8	48.7	47.6	40.7	33.2	28.0	23.0	34.0
Average Total Precipitation (in.)	2.91	2.06	2.13	1.77	2.03	1.89	0.94	1.02	1.18	2.10	3.07	3.10	24.20
Average Total SnowFall (in.)	14.2	5.1	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.1	3.1	11.7	37.1
Average Snow Depth (in.)	4	3	1	0	0	0	0	0	0	0	0	2	1

Percent of possible observations for period of record.
Max. Temp.: 98% Min. Temp.: 97.9% Precipitation: 97.7% Snowfall: 93.5% Snow Depth: 89.4%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

Appendix B-6
2000 and 2010 U.S. Census Data

2000 and 2010 U.S. Census Data for the City of Spirit Lake and Kootenai County, Idaho

James A. Sewell & Associates, LLC

U.S. Census Bureau

AMERICAN FactFinder

DP-1

Profile of General Population and Housing Characteristics: 2010
2010 Demographic Profile Data

NOTE: For more information on confidentiality protection, nonsampling error, and definitions, see http://www.census.gov/prod/cen2010/doc/dpsf.pdf.

Geography: Spirit Lake city, Idaho

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Subject	Number	Percent
SEX AND AGE		
Total population	1,945	100.0
Under 5 years	136	7.0
5 to 9 years	137	7.0
10 to 14 years	156	8.0
15 to 19 years	156	8.0
20 to 24 years	84	4.3
25 to 29 years	121	6.2
30 to 34 years	109	5.6
35 to 39 years	126	6.5
40 to 44 years	118	6.1
45 to 49 years	159	8.2
50 to 54 years	159	8.2
55 to 59 years	139	7.1
60 to 64 years	114	5.9
65 to 69 years	95	4.9
70 to 74 years	69	3.5
75 to 79 years	34	1.7
80 to 84 years	18	0.9
85 years and over	15	0.8
Median age (years)	37.8	(X)
16 years and over	1,471	75.6
18 years and over	1,406	72.3
21 years and over	1,346	69.2
62 years and over	300	15.4
65 years and over	231	11.9
Male population	978	50.3
Under 5 years	65	3.3
5 to 9 years	74	3.8
10 to 14 years	82	4.2
15 to 19 years	74	3.8
20 to 24 years	39	2.0
25 to 29 years	54	2.8
30 to 34 years	48	2.5
35 to 39 years	79	4.1

Subject	Number	Percent
40 to 44 years	51	2.6
45 to 49 years	78	4.0
50 to 54 years	87	4.5
55 to 59 years	82	4.2
60 to 64 years	51	2.6
65 to 69 years	50	2.6
70 to 74 years	33	1.7
75 to 79 years	20	1.0
80 to 84 years	8	0.4
85 years and over	3	0.2
Median age (years)	37.8	(X)
16 years and over	737	37.9
18 years and over	701	36.0
21 years and over	673	34.6
62 years and over	146	7.5
65 years and over	114	5.9
Female population	967	49.7
Under 5 years	71	3.7
5 to 9 years	63	3.2
10 to 14 years	74	3.8
15 to 19 years	82	4.2
20 to 24 years	45	2.3
25 to 29 years	67	3.4
30 to 34 years	61	3.1
35 to 39 years	47	2.4
40 to 44 years	67	3.4
45 to 49 years	81	4.2
50 to 54 years	72	3.7
55 to 59 years	57	2.9
60 to 64 years	63	3.2
65 to 69 years	45	2.3
70 to 74 years	36	1.9
75 to 79 years	14	0.7
80 to 84 years	10	0.5
85 years and over	12	0.6
Median age (years)	37.9	(X)
16 years and over	734	37.7
18 years and over	705	36.2
21 years and over	673	34.6
62 years and over	154	7.9
65 years and over	117	6.0
RACE		
Total population	1,945	100.0
One Race	1,908	98.1
White	1,874	96.3
Black or African American	3	0.2
American Indian and Alaska Native	10	0.5

Subject	Number	Percent
Asian	7	0.4
Asian Indian	0	0.0
Chinese	0	0.0
Filipino	4	0.2
Japanese	1	0.1
Korean	2	0.1
Vietnamese	0	0.0
Other Asian [1]	0	0.0
Native Hawaiian and Other Pacific Islander	2	0.1
Native Hawaiian	1	0.1
Guamanian or Chamorro	0	0.0
Samoan	0	0.0
Other Pacific Islander [2]	1	0.1
Some Other Race	12	0.6
Two or More Races	37	1.9
White; American Indian and Alaska Native [3]	24	1.2
White; Asian [3]	7	0.4
White; Black or African American [3]	2	0.1
White; Some Other Race [3]	2	0.1
Race alone or in combination with one or more other races: [4]		
White	1,910	98.2
Black or African American	5	0.3
American Indian and Alaska Native	35	1.8
Asian	14	0.7
Native Hawaiian and Other Pacific Islander	3	0.2
Some Other Race	15	0.8
HISPANIC OR LATINO		
Total population	1,945	100.0
Hispanic or Latino (of any race)	54	2.8
Mexican	35	1.8
Puerto Rican	2	0.1
Cuban	0	0.0
Other Hispanic or Latino [5]	17	0.9
Not Hispanic or Latino	1,891	97.2
HISPANIC OR LATINO AND RACE		
Total population	1,945	100.0
Hispanic or Latino	54	2.8
White alone	34	1.7
Black or African American alone	0	0.0
American Indian and Alaska Native alone	2	0.1
Asian alone	2	0.1
Native Hawaiian and Other Pacific Islander alone	0	0.0
Some Other Race alone	12	0.6
Two or More Races	4	0.2
Not Hispanic or Latino	1,891	97.2
White alone	1,840	94.6
Black or African American alone	3	0.2
American Indian and Alaska Native alone	8	0.4
Asian alone	5	0.3
Native Hawaiian and Other Pacific Islander alone	2	0.1

Subject	Number	Percent
Some Other Race alone	0	0.0
Two or More Races	33	1.7
RELATIONSHIP		
Total population	1,945	100.0
In households	1,945	100.0
Householder	739	38.0
Spouse [6]	398	20.5
Child	605	31.1
Own child under 18 years	492	25.3
Other relatives	89	4.6
Under 18 years	40	2.1
65 years and over	16	0.8
Nonrelatives	114	5.9
Under 18 years	7	0.4
65 years and over	7	0.4
Unmarried partner	69	3.5
In group quarters	0	0.0
Institutionalized population	0	0.0
Male	0	0.0
Female	0	0.0
Noninstitutionalized population	0	0.0
Male	0	0.0
Female	0	0.0
HOUSEHOLDS BY TYPE		
Total households	739	100.0
Family households (families) [7]	530	71.7
With own children under 18 years	258	34.9
Husband-wife family	398	53.9
With own children under 18 years	167	22.6
Male householder, no wife present	48	6.5
With own children under 18 years	37	5.0
Female householder, no husband present	84	11.4
With own children under 18 years	54	7.3
Nonfamily households [7]	209	28.3
Householder living alone	167	22.6
Male	92	12.4
65 years and over	20	2.7
Female	75	10.1
65 years and over	35	4.7
Households with individuals under 18 years	281	38.0
Households with individuals 65 years and over	167	22.6
Average household size	2.63	(X)
Average family size [7]	3.06	(X)
HOUSING OCCUPANCY		
Total housing units	797	100.0
Occupied housing units	739	92.7

Subject	Number	Percent
Vacant housing units	58	7.3
For rent	15	1.9
Rented, not occupied	2	0.3
For sale only	12	1.5
Sold, not occupied	1	0.1
For seasonal, recreational, or occasional use	16	2.0
All other vacants	12	1.5
Homeowner vacancy rate (percent) [8]	2.1	(X)
Rental vacancy rate (percent) [9]	7.7	(X)
HOUSING TENURE		
Occupied housing units	739	100.0
Owner-occupied housing units	560	75.8
Population in owner-occupied housing units	1,464	(X)
Average household size of owner-occupied units	2.61	(X)
Renter-occupied housing units	179	24.2
Population in renter-occupied housing units	481	(X)
Average household size of renter-occupied units	2.69	(X)

X Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] One of the four most commonly reported multiple-race combinations nationwide in Census 2000.

[4] In combination with one or more of the other races listed. The six numbers may add to more than the total population, and the six percentages may add to more than 100 percent because individuals may report more than one race.

[5] This category is composed of people whose origins are from the Dominican Republic, Spain, and Spanish-speaking Central or South American countries. It also includes general origin responses such as "Latino" or "Hispanic."

[6] "Spouse" represents spouse of the householder. It does not reflect all spouses in a household. Responses of "same-sex spouse" were edited during processing to "unmarried partner."

[7] "Family households" consist of a householder and one or more other people related to the householder by birth, marriage, or adoption. They do not include same-sex married couples even if the marriage was performed in a state issuing marriage certificates for same-sex couples. Same-sex couple households are included in the family households category if there is at least one additional person related to the householder by birth or adoption. Same-sex couple households with no relatives of the householder present are tabulated in nonfamily households. "Nonfamily households" consist of people living alone and households which do not have any members related to the householder.

[8] The homeowner vacancy rate is the proportion of the homeowner inventory that is vacant "for sale." It is computed by dividing the total number of vacant units "for sale only" by the sum of owner-occupied units, vacant units that are "for sale only," and vacant units that have been sold but not yet occupied; and then multiplying by 100.

[9] The rental vacancy rate is the proportion of the rental inventory that is vacant "for rent." It is computed by dividing the total number of vacant units "for rent" by the sum of the renter-occupied units, vacant units that are "for rent," and vacant units that have been rented but not yet occupied; and then multiplying by 100.

Source: U.S. Census Bureau, 2010 Census.

Source: U.S. Census Bureau | American FactFinder

AMERICAN FactFinder

B01003

TOTAL POPULATION

Universe: Total population
2005-2009 American Community Survey 5-Year Estimates

NOTE. Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

For information on confidentiality protection, sampling error, nonsampling error, and definitions, see Survey Methodology.

	Spirit Lake city, Idaho	
	Estimate	Margin of Error
Total	1,486	+/-343

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

While the 2005-2009 American Community Survey (ACS) data generally reflect the November 2008 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2000 data. Boundaries for urban areas have not been updated since Census 2000. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Explanation of Symbols:
1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.

Source: U.S. Census Bureau, 2005-2009 American Community Survey

DP-1

Profile of General Demographic Characteristics: 2000

Census 2000 Summary File 1 (SF 1) 100-Percent Data

NOTE: For information on confidentiality protection, nonsampling error, definitions, and count corrections see http://factfinder.census.gov/home/en/datanotes/expsf1u.htm.

Subject	Spirit Lake city, Idaho	
	Number	Percent
Total population	1,376	100.0
SEX AND AGE		
Male	669	48.6
Female	707	51.4
Under 5 years	91	6.6
5 to 9 years	110	8.0
10 to 14 years	136	9.9
15 to 19 years	99	7.2
20 to 24 years	54	3.9
25 to 34 years	187	13.6
35 to 44 years	227	16.5
45 to 54 years	185	13.4
55 to 59 years	88	6.4
60 to 64 years	60	4.4
65 to 74 years	87	6.3
75 to 84 years	40	2.9
85 years and over	12	0.9
Median age (years)	35.9	(X)
18 years and over	964	70.1
Male	479	34.8
Female	485	35.2
21 years and over	926	67.3
62 years and over	174	12.6
65 years and over	139	10.1
Male	61	4.4
Female	78	5.7
RACE		
One race	1,349	98.0
White	1,315	95.6
Black or African American	2	0.1
American Indian and Alaska Native	9	0.7
Asian	2	0.1
Asian Indian	0	0.0
Chinese	0	0.0
Filipino	1	0.1
Japanese	0	0.0
Korean	1	0.1
Vietnamese	0	0.0
Other Asian [1]	0	0.0
Native Hawaiian and Other Pacific Islander	1	0.1
Native Hawaiian	1	0.1
Guamanian or Chamorro	0	0.0
Samoan	0	0.0
Other Pacific Islander [2]	0	0.0

Subject	Spirit Lake city, Idaho	
	Number	Percent
Some other race	20	1.5
Two or more races	27	2.0
Race alone or in combination with one or more other races [3]		
White	1,342	97.5
Black or African American	3	0.2
American Indian and Alaska Native	18	1.3
Asian	9	0.7
Native Hawaiian and Other Pacific Islander	6	0.4
Some other race	28	2.0
HISPANIC OR LATINO AND RACE		
Total population	1,376	100.0
Hispanic or Latino (of any race)	33	2.4
Mexican	25	1.8
Puerto Rican	5	0.4
Cuban	0	0.0
Other Hispanic or Latino	3	0.2
Not Hispanic or Latino	1,343	97.6
White alone	1,303	94.7
RELATIONSHIP		
Total population	1,376	100.0
In households	1,376	100.0
Householder	517	37.6
Spouse	288	20.9
Child	428	31.1
Own child under 18 years	371	27.0
Other relatives	49	3.6
Under 18 years	21	1.5
Nonrelatives	94	6.8
Unmarried partner	39	2.8
In group quarters	0	0.0
Institutionalized population	0	0.0
Noninstitutionalized population	0	0.0
HOUSEHOLDS BY TYPE		
Total households	517	100.0
Family households (families)	369	71.4
With own children under 18 years	196	37.9
Married-couple family	288	55.7
With own children under 18 years	133	25.7
Female householder, no husband present	54	10.4
With own children under 18 years	44	8.5
Nonfamily households	148	28.6
Householder living alone	118	22.8
Householder 65 years and over	38	7.4
Households with individuals under 18 years	213	41.2
Households with individuals 65 years and over	103	19.9
Average household size	2.66	(X)
Average family size	3.07	(X)
HOUSING OCCUPANCY		
Total housing units	587	100.0
Occupied housing units	517	88.1
Vacant housing units	70	11.9
For seasonal, recreational, or occasional use	16	2.7
Homeowner vacancy rate (percent)	8.0	(X)
Rental vacancy rate (percent)	7.4	(X)
HOUSING TENURE		
Occupied housing units	517	100.0
Owner-occupied housing units	380	73.5
Renter-occupied housing units	137	26.5
Average household size of owner-occupied unit	2.65	(X)

Subject	Spirit Lake city, Idaho	
	Number	Percent
Average household size of renter-occupied unit	2.69	(X)

(X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000 Summary File 1, Matrices P1, P3, P4, P8, P9, P12, P13, P,17, P18, P19, P20, P23, P27, P28, P33, PCT5, PCT8, PCT11, PCT15, H1, H3, H4, H5, H11, and H12.

AMERICAN FactFinder

DP-3

Profile of Selected Economic Characteristics: 2000

Census 2000 Summary File 3 (SF 3) - Sample Data

NOTE: Data based on a sample except in P3, P4, H3, and H4. For information on confidentiality protection, sampling error, nonsampling error, definitions, and count corrections see http://factfinder.census.gov/home/en/datanotes/expsf3.htm.

Subject	Idaho		Spirit Lake city, Idaho	
	Number	Percent	Number	Percent
EMPLOYMENT STATUS				
Population 16 years and over	969,872	100.0	1,008	100.0
In labor force	641,088	66.1	566	56.2
Civilian labor force	636,237	65.6	566	56.2
Employed	599,453	61.8	476	47.2
Unemployed	36,784	3.8	90	8.9
Percent of civilian labor force	5.8	(X)	15.9	(X)
Armed Forces	4,851	0.5	0	0.0
Not in labor force	328,784	33.9	442	43.8
Females 16 years and over	488,294	100.0	500	100.0
In labor force	288,531	59.1	262	52.4
Civilian labor force	287,664	58.9	262	52.4
Employed	271,945	55.7	236	47.2
Own children under 6 years	112,639	100.0	128	100.0
All parents in family in labor force	65,079	57.8	66	51.6
COMMUTING TO WORK				
Workers 16 years and over	594,654	100.0	464	100.0
Car, truck, or van -- drove alone	457,986	77.0	351	75.6
Car, truck, or van -- carpooled	73,273	12.3	50	10.8
Public transportation (including taxicab)	6,275	1.1	0	0.0
Walked	20,747	3.5	16	3.4
Other means	8,360	1.4	4	0.9
Worked at home	28,013	4.7	43	9.3
Mean travel time to work (minutes)	20.0	(X)	33.5	(X)
Employed civilian population 16 years and over	599,453	100.0	476	100.0
OCCUPATION				
Management, professional, and related occupations	188,094	31.4	87	18.3
Service occupations	93,467	15.6	101	21.2
Sales and office occupations	151,835	25.3	122	25.6
Farming, fishing, and forestry occupations	16,249	2.7	4	0.8
Construction, extraction, and maintenance occupations	64,747	10.8	90	18.9
Production, transportation, and material moving occupations	85,061	14.2	72	15.1
INDUSTRY				
Agriculture, forestry, fishing and hunting, and mining	34,503	5.8	18	3.8
Construction	48,388	8.1	58	12.2
Manufacturing	78,625	13.1	72	15.1
Wholesale trade	21,495	3.6	13	2.7
Retail trade	75,477	12.6	63	13.2
Transportation and warehousing, and utilities	27,891	4.7	23	4.8
Information	13,779	2.3	12	2.5
Finance, insurance, real estate, and rental and leasing	30,618	5.1	24	5.0

Subject	Idaho		Spirit Lake city, Idaho	
	Number	Percent	Number	Percent
Professional, scientific, management, administrative, and waste management services	47,744	8.0	33	6.9
Educational, health and social services	115,154	19.2	81	17.0
Arts, entertainment, recreation, accommodation and food services	47,902	8.0	53	11.1
Other services (except public administration)	27,228	4.5	18	3.8
Public administration	30,649	5.1	8	1.7
CLASS OF WORKER				
Private wage and salary workers	442,529	73.8	360	75.6
Government workers	98,089	16.4	65	13.7
Self-employed workers in own not incorporated business	56,018	9.3	49	10.3
Unpaid family workers	2,817	0.5	2	0.4
INCOME IN 1999				
Households	470,133	100.0	508	100.0
Less than $10,000	40,676	8.7	72	14.2
$10,000 to $14,999	33,431	7.1	41	8.1
$15,000 to $24,999	71,921	15.3	99	19.5
$25,000 to $34,999	70,391	15.0	86	16.9
$35,000 to $49,999	89,612	19.1	110	21.7
$50,000 to $74,999	90,462	19.2	63	12.4
$75,000 to $99,999	39,249	8.3	11	2.2
$100,000 to $149,999	22,797	4.8	17	3.3
$150,000 to $199,999	5,395	1.1	9	1.8
$200,000 or more	6,199	1.3	0	0.0
Median household income (dollars)	37,572	(X)	28,854	(X)
With earnings	386,642	82.2	375	73.8
Mean earnings (dollars)	46,344	(X)	34,929	(X)
With Social Security income	118,248	25.2	170	33.5
Mean Social Security income (dollars)	11,328	(X)	9,517	(X)
With Supplemental Security Income	16,647	3.5	23	4.5
Mean Supplemental Security Income (dollars)	6,104	(X)	6,117	(X)
With public assistance income	15,988	3.4	23	4.5
Mean public assistance income (dollars)	1,824	(X)	1,339	(X)
With retirement income	73,521	15.6	98	19.3
Mean retirement income (dollars)	15,786	(X)	14,617	(X)
Families	337,884	100.0	361	100.0
Less than $10,000	16,047	4.7	28	7.8
$10,000 to $14,999	15,773	4.7	31	8.6
$15,000 to $24,999	44,523	13.2	59	16.3
$25,000 to $34,999	50,263	14.9	72	19.9
$35,000 to $49,999	70,384	20.8	84	23.3
$50,000 to $74,999	76,202	22.6	63	17.5
$75,000 to $99,999	34,470	10.2	7	1.9
$100,000 to $149,999	20,110	6.0	14	3.9
$150,000 to $199,999	4,746	1.4	3	0.8
$200,000 or more	5,366	1.6	0	0.0
Median family income (dollars)	43,490	(X)	32,337	(X)
Per capita income (dollars)	17,841	(X)	13,592	(X)
Median earnings (dollars):				
Male full-time, year-round workers	32,603	(X)	25,875	(X)
Female full-time, year-round workers	22,939	(X)	18,092	(X)
POVERTY STATUS IN 1999 (below poverty level)				
Families	28,131	(X)	42	(X)
Percent below poverty level	(X)	8.3	(X)	11.6
With related children under 18 years	22,205	(X)	36	(X)
Percent below poverty level	(X)	12.2	(X)	16.4
With related children under 5 years	11,846	(X)	15	(X)
Percent below poverty level	(X)	16.0	(X)	19.2
Families with female householder, no husband present	10,982	(X)	20	(X)

Subject	Idaho		Spirit Lake city, Idaho	
	Number	Percent	Number	Percent
Percent below poverty level	(X)	27.7	(X)	48.8
With related children under 18 years	10,178	(X)	19	(X)
Percent below poverty level	(X)	35.3	(X)	47.5
With related children under 5 years	4,865	(X)	12	(X)
Percent below poverty level	(X)	49.2	(X)	70.6
Individuals	148,732	(X)	221	(X)
Percent below poverty level	(X)	11.8	(X)	16.4
18 years and over	96,864	(X)	132	(X)
Percent below poverty level	(X)	10.8	(X)	13.9
65 years and over	11,635	(X)	10	(X)
Percent below poverty level	(X)	8.3	(X)	6.3
Related children under 18 years	49,787	(X)	81	(X)
Percent below poverty level	(X)	13.8	(X)	20.8
Related children 5 to 17 years	33,275	(X)	59	(X)
Percent below poverty level	(X)	12.6	(X)	20.8
Unrelated individuals 15 years and over	50,259	(X)	67	(X)
Percent below poverty level	(X)	25.9	(X)	29.4

(X) Not applicable.

Detailed Occupation Code List (PDF 42KB)
Detailed Industry Code List (PDF 46KB)
User note on employment status data
Source: U.S. Census Bureau, Census 2000 Summary File 3, Matrices P30, P32, P33, P43, P46, P49, P50, P51, P52, P53, P58, P62, P63, P64, P65, P67, P71, P72, P73, P74, P76, P77, P82, P87, P90, PCT47, PCT52, and PCT53

U.S. Census Bureau

AMERICAN FactFinder

DP03

SELECTED ECONOMIC CHARACTERISTICS

2006-2010 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.

Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, for 2010, the 2010 Census provides the official counts of the population and housing units for the nation, states, counties, cities and towns. For 2006 to 2009, the Population Estimates Program provides intercensal estimates of the population for the nation, states, and counties.

Subject	Spirit Lake city, Idaho			
	Estimate	Estimate Margin of Error	Percent	Percent Margin of Error
EMPLOYMENT STATUS				
Population 16 years and over	1,111	+/-207	1,111	(X)
In labor force	654	+/-145	58.9%	+/-5.4
Civilian labor force	654	+/-145	58.9%	+/-5.4
Employed	621	+/-136	55.9%	+/-5.8
Unemployed	33	+/-36	3.0%	+/-3.1
Armed Forces	0	+/-119	0.0%	+/-2.9
Not in labor force	457	+/-97	41.1%	+/-5.4
Civilian labor force	654	+/-145	654	(X)
Percent Unemployed	(X)	(X)	5.0%	+/-5.1
Females 16 years and over	608	+/-122	608	(X)
In labor force	317	+/-91	52.1%	+/-9.2
Civilian labor force	317	+/-91	52.1%	+/-9.2
Employed	290	+/-82	47.7%	+/-8.9
Own children under 6 years	100	+/-67	100	(X)
All parents in family in labor force	47	+/-44	47.0%	+/-33.3
Own children 6 to 17 years	297	+/-107	297	(X)
All parents in family in labor force	157	+/-71	52.9%	+/-18.1
COMMUTING TO WORK				
Workers 16 years and over	594	+/-129	594	(X)
Car, truck, or van -- drove alone	433	+/-109	72.9%	+/-9.2
Car, truck, or van -- carpooled	95	+/-52	16.0%	+/-8.1
Public transportation (excluding taxicab)	3	+/-5	0.5%	+/-0.7
Walked	7	+/-12	1.2%	+/-1.9
Other means	29	+/-23	4.9%	+/-3.7
Worked at home	27	+/-21	4.5%	+/-3.4
Mean travel time to work (minutes)	28.8	+/-3.5	(X)	(X)
OCCUPATION				
Civilian employed population 16 years and over	621	+/-136	621	(X)
Management, business, science, and arts occupations	121	+/-57	19.5%	+/-8.1
Service occupations	126	+/-51	20.3%	+/-7.6
Sales and office occupations	130	+/-55	20.9%	+/-7.1
Natural resources, construction, and maintenance occupations	122	+/-49	19.6%	+/-6.3

Subject	Spirit Lake city, Idaho			
	Estimate	Estimate Margin of Error	Percent	Percent Margin of Error
Production, transportation, and material moving occupations	122	+/-54	19.6%	+/-7.6
INDUSTRY				
Civilian employed population 16 years and over	621	+/-136	621	(X)
Agriculture, forestry, fishing and hunting, and mining	17	+/-20	2.7%	+/-3.1
Construction	87	+/-41	14.0%	+/-5.8
Manufacturing	88	+/-55	14.2%	+/-8.3
Wholesale trade	17	+/-17	2.7%	+/-2.8
Retail trade	97	+/-51	15.6%	+/-7.0
Transportation and warehousing, and utilities	26	+/-18	4.2%	+/-2.7
Information	18	+/-20	2.9%	+/-3.2
Finance and insurance, and real estate and rental and leasing	9	+/-14	1.4%	+/-2.1
Professional, scientific, and management, and administrative and waste management services	26	+/-25	4.2%	+/-3.9
Educational services, and health care and social assistance	96	+/-44	15.5%	+/-6.7
Arts, entertainment, and recreation, and accommodation and food services	105	+/-51	16.9%	+/-7.3
Other services, except public administration	22	+/-19	3.5%	+/-3.1
Public administration	13	+/-11	2.1%	+/-1.9
CLASS OF WORKER				
Civilian employed population 16 years and over	621	+/-136	621	(X)
Private wage and salary workers	517	+/-136	83.3%	+/-8.1
Government workers	78	+/-40	12.6%	+/-6.7
Self-employed in own not incorporated business workers	26	+/-23	4.2%	+/-3.6
Unpaid family workers	0	+/-119	0.0%	+/-5.1
INCOME AND BENEFITS (IN 2010 INFLATION-ADJUSTED DOLLARS)				
Total households	552	+/-85	552	(X)
Less than $10,000	46	+/-24	8.3%	+/-4.5
$10,000 to $14,999	30	+/-22	5.4%	+/-3.9
$15,000 to $24,999	89	+/-42	16.1%	+/-7.3
$25,000 to $34,999	62	+/-30	11.2%	+/-5.7
$35,000 to $49,999	119	+/-46	21.6%	+/-7.4
$50,000 to $74,999	129	+/-52	23.4%	+/-8.2
$75,000 to $99,999	56	+/-32	10.1%	+/-5.5
$100,000 to $149,999	7	+/-12	1.3%	+/-2.2
$150,000 to $199,999	14	+/-17	2.5%	+/-3.1
$200,000 or more	0	+/-119	0.0%	+/-5.7
Median household income (dollars)	41,563	+/-7,314	(X)	(X)
Mean household income (dollars)	45,680	+/-5,922	(X)	(X)
With earnings	455	+/-85	82.4%	+/-6.9
Mean earnings (dollars)	44,546	+/-6,692	(X)	(X)
With Social Security	217	+/-58	39.3%	+/-8.3
Mean Social Security income (dollars)	15,113	+/-2,454	(X)	(X)
With retirement income	60	+/-31	10.9%	+/-5.8
Mean retirement income (dollars)	11,087	+/-7,177	(X)	(X)
With Supplemental Security Income	3	+/-6	0.5%	+/-1.0
Mean Supplemental Security Income (dollars)	-	**	(X)	(X)
With cash public assistance income	10	+/-12	1.8%	+/-2.2
Mean cash public assistance income (dollars)	1,530	+/-1,698	(X)	(X)
With Food Stamp/SNAP benefits in the past 12 months	82	+/-38	14.9%	+/-6.8
Families	395	+/-83	395	(X)
Less than $10,000	38	+/-24	9.6%	+/-5.8
$10,000 to $14,999	8	+/-14	2.0%	+/-3.6
$15,000 to $24,999	61	+/-35	15.4%	+/-8.4
$25,000 to $34,999	33	+/-23	8.4%	+/-5.5
$35,000 to $49,999	94	+/-43	23.8%	+/-9.2
$50,000 to $74,999	101	+/-43	25.6%	+/-9.3

Subject	Spirit Lake city, Idaho			
	Estimate	Estimate Margin of Error	Percent	Percent Margin of Error
$75,000 to $99,999	48	+/-31	12.2%	+/-7.5
$100,000 to $149,999	7	+/-12	1.8%	+/-3.1
$150,000 to $199,999	5	+/-8	1.3%	+/-2.0
$200,000 or more	0	+/-119	0.0%	+/-7.9
Median family income (dollars)	44,618	+/-4,923	(X)	(X)
Mean family income (dollars)	47,009	+/-6,724	(X)	(X)
Per capita income (dollars)	17,267	+/-2,052	(X)	(X)
Nonfamily households	157	+/-54	157	(X)
Median nonfamily income (dollars)	31,023	+/-11,564	(X)	(X)
Mean nonfamily income (dollars)	30,973	+/-6,933	(X)	(X)
Median earnings for workers (dollars)	22,008	+/-6,597	(X)	(X)
Median earnings for male full-time, year-round workers (dollars)	42,813	+/-15,040	(X)	(X)
Median earnings for female full-time, year-round workers (dollars)	26,667	+/-1,919	(X)	(X)
HEALTH INSURANCE COVERAGE				
Civilian noninstitutionalized population	(X)	(X)	(X)	(X)
With health insurance coverage	(X)	(X)	(X)	(X)
With private health insurance	(X)	(X)	(X)	(X)
With public coverage	(X)	(X)	(X)	(X)
No health insurance coverage	(X)	(X)	(X)	(X)
Civilian noninstitutionalized population under 18 years	(X)	(X)	(X)	(X)
No health insurance coverage	(X)	(X)	(X)	(X)
Civilian noninstitutionalized population 18 to 64 years	(X)	(X)	(X)	(X)
In labor force:	(X)	(X)	(X)	(X)
Employed:	(X)	(X)	(X)	(X)
With health insurance coverage	(X)	(X)	(X)	(X)
With private health insurance	(X)	(X)	(X)	(X)
With public coverage	(X)	(X)	(X)	(X)
No health insurance coverage	(X)	(X)	(X)	(X)
Unemployed:	(X)	(X)	(X)	(X)
With health insurance coverage	(X)	(X)	(X)	(X)
With private health insurance	(X)	(X)	(X)	(X)
With public coverage	(X)	(X)	(X)	(X)
No health insurance coverage	(X)	(X)	(X)	(X)
Not in labor force:	(X)	(X)	(X)	(X)
With health insurance coverage	(X)	(X)	(X)	(X)
With private health insurance	(X)	(X)	(X)	(X)
With public coverage	(X)	(X)	(X)	(X)
No health insurance coverage	(X)	(X)	(X)	(X)
PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL				
All families	(X)	(X)	11.6%	+/-6.9
With related children under 18 years	(X)	(X)	8.8%	+/-9.3
With related children under 5 years only	(X)	(X)	0.0%	+/-100.0
Married couple families	(X)	(X)	4.6%	+/-5.7
With related children under 18 years	(X)	(X)	1.3%	+/-3.2
With related children under 5 years only	(X)	(X)	0.0%	+/-100.0
Families with female householder, no husband present	(X)	(X)	29.9%	+/-25.7
With related children under 18 years	(X)	(X)	32.7%	+/-32.1
With related children under 5 years only	(X)	(X)	-	**
All people	(X)	(X)	11.2%	+/-5.0
Under 18 years	(X)	(X)	7.0%	+/-7.7
Related children under 18 years	(X)	(X)	7.0%	+/-7.7
Related children under 5 years	(X)	(X)	0.0%	+/-35.1
Related children 5 to 17 years	(X)	(X)	8.5%	+/-9.1
18 years and over	(X)	(X)	12.9%	+/-5.3
18 to 64 years	(X)	(X)	11.6%	+/-5.9

Subject	Spirit Lake city, Idaho			
	Estimate	Estimate Margin of Error	Percent	Percent Margin of Error
65 years and over	(X)	(X)	20.4%	+/-16.3
People in families	(X)	(X)	8.4%	+/-5.2
Unrelated individuals 15 years and over	(X)	(X)	25.8%	+/-11.3

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

There were changes in the edit between 2009 and 2010 regarding Supplemental Security Income (SSI) and Social Security. The changes in the edit loosened restrictions on disability requirements for receipt of SSI resulting in an increase in the total number of SSI recipients in the American Community Survey. The changes also loosened restrictions on possible reported monthly amounts in Social Security income resulting in higher Social Security aggregate amounts. These results more closely match administrative counts compiled by the Social Security Administration.

Workers include members of the Armed Forces and civilians who were at work last week.

Industry codes are 4-digit codes and are based on the North American Industry Classification System 2007. The Industry categories adhere to the guidelines issued in Clarification Memorandum No. 2, "NAICS Alternate Aggregation Structure for Use By U.S. Statistical Agencies," issued by the Office of Management and Budget.

Occupation codes are 4-digit codes and are based on the Standard Occupational Classification (SOC) 2010. The 2010 Census occupation codes were updated in accordance with the 2010 revision of the SOC. To allow for the creation of 2006-2010 and 2008-2010 tables, occupation data in the multiyear files (2006-2010 and 2008-2010) were recoded to 2010 Census occupation codes. We recommend using caution when comparing data coded using 2010 Census occupation codes with data coded using previous Census occupation codes. For more information on the Census occupation code changes, please visit our website at http://www.census.gov/hhes/www/ioindex/.

While the 2006-2010 American Community Survey (ACS) data generally reflect the December 2009 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2000 data. Boundaries for urban areas have not been updated since Census 2000. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Source: U.S. Census Bureau, 2006-2010 American Community Survey

Explanation of Symbols:

1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
7. An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
8. An '(X)' means that the estimate is not applicable or not available.

U.S. Census Bureau

AMERICAN FactFinder

DP-1 | Profile of General Population and Housing Characteristics: 2010

2010 Demographic Profile Data

NOTE: For more information on confidentiality protection, nonsampling error, and definitions, see http://www.census.gov/prod/cen2010/doc/dpsf.pdf.

Geography: Kootenai County, Idaho

Subject	Number	Percent
SEX AND AGE		
Total population	138,494	100.0
Under 5 years	8,963	6.5
5 to 9 years	9,466	6.8
10 to 14 years	9,743	7.0
15 to 19 years	9,915	7.2
20 to 24 years	8,165	5.9
25 to 29 years	8,501	6.1
30 to 34 years	8,241	6.0
35 to 39 years	8,335	6.0
40 to 44 years	8,913	6.4
45 to 49 years	9,775	7.1
50 to 54 years	10,089	7.3
55 to 59 years	9,579	6.9
60 to 64 years	8,731	6.3
65 to 69 years	6,573	4.7
70 to 74 years	4,891	3.5
75 to 79 years	3,562	2.6
80 to 84 years	2,629	1.9
85 years and over	2,423	1.7
Median age (years)	38.9	(X)
16 years and over	108,277	78.2
18 years and over	104,250	75.3
21 years and over	98,585	71.2
62 years and over	25,215	18.2
65 years and over	20,078	14.5
Male population	68,257	49.3
Under 5 years	4,605	3.3
5 to 9 years	4,839	3.5
10 to 14 years	4,978	3.6
15 to 19 years	5,128	3.7
20 to 24 years	4,121	3.0
25 to 29 years	4,189	3.0
30 to 34 years	4,094	3.0
35 to 39 years	4,234	3.1
40 to 44 years	4,411	3.2
45 to 49 years	4,701	3.4
50 to 54 years	4,851	3.5
55 to 59 years	4,586	3.3
60 to 64 years	4,229	3.1
65 to 69 years	3,198	2.3
70 to 74 years	2,440	1.8
75 to 79 years	1,688	1.2
80 to 84 years	1,157	0.8
85 years and over	808	0.6

Subject	Number	Percent
Median age (years)	37.7	(X)
16 years and over	52,782	38.1
18 years and over	50,688	36.6
21 years and over	47,791	34.5
62 years and over	11,789	8.5
65 years and over	9,291	6.7
Female population	70,237	50.7
Under 5 years	4,358	3.1
5 to 9 years	4,627	3.3
10 to 14 years	4,765	3.4
15 to 19 years	4,787	3.5
20 to 24 years	4,044	2.9
25 to 29 years	4,312	3.1
30 to 34 years	4,147	3.0
35 to 39 years	4,101	3.0
40 to 44 years	4,502	3.3
45 to 49 years	5,074	3.7
50 to 54 years	5,238	3.8
55 to 59 years	4,993	3.6
60 to 64 years	4,502	3.3
65 to 69 years	3,375	2.4
70 to 74 years	2,451	1.8
75 to 79 years	1,874	1.4
80 to 84 years	1,472	1.1
85 years and over	1,615	1.2
Median age (years)	40.0	(X)
16 years and over	55,495	40.1
18 years and over	53,562	38.7
21 years and over	50,794	36.7
62 years and over	13,426	9.7
65 years and over	10,787	7.8
RACE		
Total population	138,494	100.0
One Race	135,172	97.6
White	130,844	94.5
Black or African American	416	0.3
American Indian and Alaska Native	1,781	1.3
Asian	961	0.7
Asian Indian	114	0.1
Chinese	173	0.1
Filipino	262	0.2
Japanese	130	0.1
Korean	106	0.1
Vietnamese	73	0.1
Other Asian [1]	103	0.1
Native Hawaiian and Other Pacific Islander	129	0.1
Native Hawaiian	61	0.0
Guamanian or Chamorro	19	0.0
Samoan	25	0.0
Other Pacific Islander [2]	24	0.0
Some Other Race	1,041	0.8
Two or More Races	3,322	2.4
White; American Indian and Alaska Native [3]	1,456	1.1
White; Asian [3]	636	0.5
White; Black or African American [3]	401	0.3
White; Some Other Race [3]	324	0.2
Race alone or in combination with one or more other races: [4]		
White	134,013	96.8
Black or African American	950	0.7
American Indian and Alaska Native	3,449	2.5

Subject	Number	Percent
Asian	1,796	1.3
Native Hawaiian and Other Pacific Islander	371	0.3
Some Other Race	1,492	1.1
HISPANIC OR LATINO		
Total population	138,494	100.0
Hispanic or Latino (of any race)	5,268	3.8
Mexican	3,529	2.5
Puerto Rican	319	0.2
Cuban	69	0.0
Other Hispanic or Latino [5]	1,351	1.0
Not Hispanic or Latino	133,226	96.2
HISPANIC OR LATINO AND RACE		
Total population	138,494	100.0
Hispanic or Latino	5,268	3.8
White alone	3,390	2.4
Black or African American alone	35	0.0
American Indian and Alaska Native alone	211	0.2
Asian alone	36	0.0
Native Hawaiian and Other Pacific Islander alone	12	0.0
Some Other Race alone	924	0.7
Two or More Races	660	0.5
Not Hispanic or Latino	133,226	96.2
White alone	127,454	92.0
Black or African American alone	381	0.3
American Indian and Alaska Native alone	1,570	1.1
Asian alone	925	0.7
Native Hawaiian and Other Pacific Islander alone	117	0.1
Some Other Race alone	117	0.1
Two or More Races	2,662	1.9
RELATIONSHIP		
Total population	138,494	100.0
In households	137,006	98.9
Householder	54,200	39.1
Spouse [6]	29,233	21.1
Child	39,152	28.3
Own child under 18 years	31,098	22.5
Other relatives	5,812	4.2
Under 18 years	2,329	1.7
65 years and over	891	0.6
Nonrelatives	8,609	6.2
Under 18 years	723	0.5
65 years and over	400	0.3
Unmarried partner	3,829	2.8
In group quarters	1,488	1.1
Institutionalized population	917	0.7
Male	475	0.3
Female	442	0.3
Noninstitutionalized population	571	0.4
Male	294	0.2
Female	277	0.2
HOUSEHOLDS BY TYPE		
Total households	54,200	100.0
Family households (families) [7]	37,316	68.8
With own children under 18 years	16,258	30.0
Husband-wife family	29,233	53.9
With own children under 18 years	11,312	20.9
Male householder, no wife present	2,676	4.9
With own children under 18 years	1,627	3.0
Female householder, no husband present	5,407	10.0
With own children under 18 years	3,319	6.1

Subject	Number	Percent
Nonfamily households [7]	16,884	31.2
Householder living alone	13,170	24.3
Male	5,755	10.6
65 years and over	1,526	2.8
Female	7,415	13.7
65 years and over	3,633	6.7
Households with individuals under 18 years	17,797	32.8
Households with individuals 65 years and over	14,256	26.3
Average household size	2.53	(X)
Average family size [7]	2.99	(X)
HOUSING OCCUPANCY		
Total housing units	63,177	100.0
Occupied housing units	54,200	85.8
Vacant housing units	8,977	14.2
For rent	1,326	2.1
Rented, not occupied	66	0.1
For sale only	1,283	2.0
Sold, not occupied	169	0.3
For seasonal, recreational, or occasional use	5,181	8.2
All other vacants	952	1.5
Homeowner vacancy rate (percent) [8]	3.2	(X)
Rental vacancy rate (percent) [9]	7.7	(X)
HOUSING TENURE		
Occupied housing units	54,200	100.0
Owner-occupied housing units	38,353	70.8
Population in owner-occupied housing units	98,338	(X)
Average household size of owner-occupied units	2.56	(X)
Renter-occupied housing units	15,847	29.2
Population in renter-occupied housing units	38,668	(X)
Average household size of renter-occupied units	2.44	(X)

X Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] One of the four most commonly reported multiple-race combinations nationwide in Census 2000.

[4] In combination with one or more of the other races listed. The six numbers may add to more than the total population, and the six percentages may add to more than 100 percent because individuals may report more than one race.

[5] This category is composed of people whose origins are from the Dominican Republic, Spain, and Spanish-speaking Central or South American countries. It also includes general origin responses such as "Latino" or "Hispanic."

[6] "Spouse" represents spouse of the householder. It does not reflect all spouses in a household. Responses of "same-sex spouse" were edited during processing to "unmarried partner."

[7] "Family households" consist of a householder and one or more other people related to the householder by birth, marriage, or adoption. They do not include same-sex married couples even if the marriage was performed in a state issuing marriage certificates for same-sex couples. Same-sex couple households are included in the family households category if there is at least one additional person related to the householder by birth or adoption. Same-sex couple households with no relatives of the householder present are tabulated in nonfamily households. "Nonfamily households" consist of people living alone and households which do not have any members related to the householder.

[8] The homeowner vacancy rate is the proportion of the homeowner inventory that is vacant "for sale." It is computed by dividing the total number of vacant units "for sale only" by the sum of owner-occupied units, vacant units that are "for sale only," and vacant units that have been sold but not yet occupied; and then multiplying by 100.

[9] The rental vacancy rate is the proportion of the rental inventory that is vacant "for rent." It is computed by dividing the total number of vacant units "for rent" by the sum of the renter-occupied units, vacant units that are "for rent," and vacant units that have been rented but not yet occupied; and then multiplying by 100.

Source: U.S. Census Bureau, 2010 Census.

U.S. Census Bureau

AMERICAN FactFinder

B01003

TOTAL POPULATION

Universe: Total population
2008 American Community Survey 1-Year Estimates

NOTE. Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

For information on confidentiality protection, sampling error, nonsampling error, and definitions, see Survey Methodology.

	Kootenai County, Idaho	
	Estimate	Margin of Error
Total	137,475	*****

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

Notes:

While the 2008 American Community Survey (ACS) data generally reflect the November 2007 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities. The 2008 Puerto Rico Community Survey (PRCS) data generally reflect the November 2007 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in PRCS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2000 data. Boundaries for urban areas have not been updated since Census 2000. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Explanation of Symbols:
1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.

Source: U.S. Census Bureau, 2008 American Community Survey

U.S. Census Bureau

AMERICAN FactFinder

DP-1

Profile of General Demographic Characteristics: 2000

Census 2000 Summary File 1 (SF 1) 100-Percent Data

NOTE: For information on confidentiality protection, nonsampling error, definitions, and count corrections see http://factfinder.census.gov/home/en/datanotes/expsf1u.htm.

Subject	Kootenai County, Idaho	
	Number	Percent
Total population	108,685	100.0
SEX AND AGE		
Male	53,812	49.5
Female	54,873	50.5
Under 5 years	7,456	6.9
5 to 9 years	8,245	7.6
10 to 14 years	8,600	7.9
15 to 19 years	8,263	7.6
20 to 24 years	6,357	5.8
25 to 34 years	13,653	12.6
35 to 44 years	16,817	15.5
45 to 54 years	15,774	14.5
55 to 59 years	5,659	5.2
60 to 64 years	4,516	4.2
65 to 74 years	7,127	6.6
75 to 84 years	4,609	4.2
85 years and over	1,609	1.5
Median age (years)	36.1	(X)
18 years and over	79,185	72.9
Male	38,553	35.5
Female	40,632	37.4
21 years and over	74,732	68.8
62 years and over	15,911	14.6
65 years and over	13,345	12.3
Male	5,870	5.4
Female	7,475	6.9
RACE		
One race	106,941	98.4
White	104,168	95.8
Black or African American	183	0.2
American Indian and Alaska Native	1,334	1.2
Asian	539	0.5
Asian Indian	37	0.0
Chinese	79	0.1
Filipino	152	0.1
Japanese	105	0.1
Korean	65	0.1
Vietnamese	51	0.0
Other Asian [1]	50	0.0
Native Hawaiian and Other Pacific Islander	74	0.1
Native Hawaiian	39	0.0
Guamanian or Chamorro	9	0.0
Samoan	12	0.0
Other Pacific Islander [2]	14	0.0

Subject	Kootenai County, Idaho	
	Number	Percent
Some other race	643	0.6
Two or more races	1,744	1.6
Race alone or in combination with one or more other races [3]		
White	105,823	97.4
Black or African American	359	0.3
American Indian and Alaska Native	2,308	2.1
Asian	908	0.8
Native Hawaiian and Other Pacific Islander	196	0.2
Some other race	957	0.9
HISPANIC OR LATINO AND RACE		
Total population	108,685	100.0
Hispanic or Latino (of any race)	2,528	2.3
Mexican	1,534	1.4
Puerto Rican	162	0.1
Cuban	48	0.0
Other Hispanic or Latino	784	0.7
Not Hispanic or Latino	106,157	97.7
White alone	102,570	94.4
RELATIONSHIP		
Total population	108,685	100.0
In households	107,285	98.7
Householder	41,308	38.0
Spouse	24,213	22.3
Child	32,453	29.9
Own child under 18 years	27,189	25.0
Other relatives	3,488	3.2
Under 18 years	1,388	1.3
Nonrelatives	5,823	5.4
Unmarried partner	2,225	2.0
In group quarters	1,400	1.3
Institutionalized population	928	0.9
Noninstitutionalized population	472	0.4
HOUSEHOLDS BY TYPE		
Total households	41,308	100.0
Family households (families)	29,668	71.8
With own children under 18 years	14,397	34.9
Married-couple family	24,213	58.6
With own children under 18 years	10,721	26.0
Female householder, no husband present	3,784	9.2
With own children under 18 years	2,565	6.2
Nonfamily households	11,640	28.2
Householder living alone	9,041	21.9
Householder 65 years and over	3,442	8.3
Households with individuals under 18 years	15,439	37.4
Households with individuals 65 years and over	9,222	22.3
Average household size	2.60	(X)
Average family size	3.03	(X)
HOUSING OCCUPANCY		
Total housing units	46,607	100.0
Occupied housing units	41,308	88.6
Vacant housing units	5,299	11.4
For seasonal, recreational, or occasional use	3,002	6.4
Homeowner vacancy rate (percent)	2.2	(X)
Rental vacancy rate (percent)	7.8	(X)
HOUSING TENURE		
Occupied housing units	41,308	100.0
Owner-occupied housing units	30,785	74.5
Renter-occupied housing units	10,523	25.5
Average household size of owner-occupied unit	2.66	(X)

Subject	Kootenai County, Idaho	
	Number	Percent
Average household size of renter-occupied unit	2.40	(X)

(X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000 Summary File 1, Matrices P1, P3, P4, P8, P9, P12, P13, P,17, P18, P19, P20, P23, P27, P28, P33, PCT5, PCT8, PCT11, PCT15, H1, H3, H4, H5, H11, and H12.

3/27/95

IDAHO
Population of Counties by Decennial Census: 1900 to 1990
Compiled and edited by Richard Forstall
Population Division
US Bureau of the Census
Washington, DC 20233

Please see file, 1900-90.doc for explanatory notes and documentation.

FIPS	1990	1980	1970	1960	
00000	248709873	226545805	203211926	179323175	United States
16000	1006749	943935	712567	667191	Idaho
16001	205775	173036	112230	93460	Ada County
16003	3254	3347	2877	2978	Adams County
16005	66026	65421	52200	49342	Bannock County
16007	6084	6931	5801	7148	Bear Lake County
16009	7937	8292	6230	6036	Benewah County
16011	37583	36489	29167	28218	Bingham County
16013	13552	9841	5749	4598	Blaine County
16015	3509	2999	1763	1646	Boise County
16017	26622	24163	15560	15587	Bonner County
16019	72207	65980	51250	46906	Bonneville County
16021	8332	7289	6371	5809	Boundary County
16023	2918	3342	2925	3498	Butte County
16025	727	818	728	917	Camas County
16027	90076	83756	61288	57662	Canyon County
16029	6963	8695	6534	5976	Caribou County
16031	19532	19427	17017	16121	Cassia County
16033	762	798	741	915	Clark County
16035	8505	10390	10871	8548	Clearwater County
16037	4133	3385	2967	2996	Custer County
16039	21205	21565	17479	16719	Elmore County
16041	9232	8895	7373	8457	Franklin County
16043	10937	10813	8710	8679	Fremont County
16045	11844	11972	9387	9127	Gem County
16047	11633	11874	8645	9544	Gooding County
16049	13783	14769	12891	13542	Idaho County
16051	16543	15304	11619	11672	Jefferson County
16053	15138	14840	10253	11712	Jerome County
16055	69795	59770	35332	29556	Kootenai County
16057	30617	28749	24891	21170	Latah County
16059	6899	7460	5566	5816	Lemhi County
16061	3516	4118	3867	4423	Lewis County
16063	3308	3436	3057	3686	Lincoln County
16065	23674	19480	13452	9417	Madison County
16067	19361	19718	15731	14394	Minidoka County
16069	33754	33220	30376	27066	Nez Perce County
16071	3492	3258	2864	3603	Oneida County
16073	8392	8272	6422	6375	Owyhee County
16075	16434	15722	12401	12363	Payette County
16077	7086	6844	4864	4111	Power County
16079	13931	19226	19718	20876	Shoshone County
16081	3439	2897	2351	2639	Teton County
16083	53580	52927	41807	41842	Twin Falls County
16085	6109	5604	3609	3663	Valley County
16087	8550	8803	7633	8378	Washington County

FIPS	1950	1940	1930	1920	
00000	151325798	132164569	123202624	106021537	United States
16000	588637	524873	445032	431866	Idaho
16001	70649	50401	37925	35213	Ada County
16003	3347	3407	2867	2966	Adams County
16005	41745	34759	31266	27532	Bannock County
16007	6834	7911	7872	8783	Bear Lake County
16009	6173	7332	6371	6997	Benewah County
16011	23271	21044	18561	18310	Bingham County
16013	5384	5295	3768	4473	Blaine County
16015	1776	2333	1847	1822	Boise County
16017	14853	15667	13152	12957	Bonner County
16019	30210	25697	19664	17501	Bonneville County
16021	5908	5987	4555	4474	Boundary County
16023	2722	1877	1934	2940	Butte County
16025	1079	1360	1411	1730	Camas County
16027	53597	40987	30930	26932	Canyon County
16029	5576	2284	2121	2191	Caribou County
16031	14629	14430	13116	15659	Cassia County
16033	918	1005	1122	1886	Clark County
16035	8217	8243	6599	4993	Clearwater County
16037	3318	3549	3162	3550	Custer County
16039	6687	5518	4491	5087	Elmore County
16041	9867	10229	9379	8650	Franklin County
16043	9351	10304	9924	10380	Fremont County
16045	8730	9544	7419	6427	Gem County
16047	11101	9257	7580	7548	Gooding County
16049	11423	12691	10107	11749	Idaho County
16051	10495	10762	9171	9441	Jefferson County
16053	12080	9900	8358	5729	Jerome County
16055	24947	22283	19469	17878	Kootenai County
16057	20971	18804	17798	18092	Latah County
16059	6278	6521	4643	5164	Lemhi County
16061	4208	4666	5238	5851	Lewis County
16063	4256	4230	3242	3446	Lincoln County
16065	9156	9186	8316	9167	Madison County
16067	9785	9870	8403	9035	Minidoka County
16069	22658	18873	17591	15253	Nez Perce County
16071	4387	5417	5870	6723	Oneida County
16073	6307	5652	4103	4694	Owyhee County
16075	11921	9511	7318	7021	Payette County
16077	3988	3965	4457	5105	Power County
16079	22806	21230	19060	14250	Shoshone County
16081	3204	3601	3573	3921	Teton County
16083	40979	36403	29828	28398	Twin Falls County
16085	4270	4035	3488	2524	Valley County
16087	8576	8853	7962	9424	Washington County

FIPS	1910	1900	
00000	92228496	76212168	United States
16000	325594	161772	Idaho
16001	29088	11559	Ada County
16003	---	---	Adams County
16005	19242	11702	Bannock County
16007	7729	7051	Bear Lake County
16009	---	---	Benewah County
16011	23306	10447	Bingham County
16013	8387	4900	Blaine County

16015	5250	4174	Boise County
16017	13588	---	Bonner County
16019	---	---	Bonneville County
16021	---	---	Boundary County
16023	---	---	Butte County
16025	---	---	Camas County
16027	25323	7497	Canyon County
16029	---	---	Caribou County
16031	7197	3951	Cassia County
16033	---	---	Clark County
16035	---	---	Clearwater County
16037	3001	2049	Custer County
16039	4785	2286	Elmore County
16041	---	---	Franklin County
16043	24606	12821	Fremont County
16045	---	---	Gem County
16047	---	---	Gooding County
16049	12384	9121	Idaho County
16051	---	---	Jefferson County
16053	---	---	Jerome County
16055	22747	10216	Kootenai County
16057	18818	13451	Latah County
16059	4786	3446	Lemhi County
16061	---	---	Lewis County
16063	12676	1784	Lincoln County
16065	---	---	Madison County
16067	---	---	Minidoka County
16069	24860	13748	Nez Perce County
16071	15170	8933	Oneida County
16073	4044	3804	Owyhee County
16075	---	---	Payette County
16077	---	---	Power County
16079	13963	11950	Shoshone County
16081	---	---	Teton County
16083	13543	---	Twin Falls County
16085	---	---	Valley County
16087	11101	6882	Washington County

State & County QuickFacts

Kootenai County, Idaho

People QuickFacts	Kootenai County	Idaho
Population, 2011 estimate	141,132	1,584,985
Population, 2010 (April 1) estimates base	138,494	1,567,582
Population, percent change, April 1, 2010 to July 1, 2011	1.9%	1.1%
Population, 2010	138,494	1,567,582
Persons under 5 years, percent, 2011	6.4%	7.5%
Persons under 18 years, percent, 2011	24.4%	27.0%
Persons 65 years and over, percent, 2011	14.9%	12.8%
Female persons, percent, 2011	50.6%	49.9%
White persons, percent, 2011 (a)	95.2%	93.9%
Black persons, percent, 2011 (a)	0.4%	0.8%
American Indian and Alaska Native persons, percent, 2011 (a)	1.4%	1.7%
Asian persons, percent, 2011 (a)	0.8%	1.3%
Native Hawaiian and Other Pacific Islander persons, percent, 2011 (a)	0.1%	0.2%
Persons reporting two or more races, percent, 2011	2.2%	2.1%
Persons of Hispanic or Latino Origin, percent, 2011 (b)	4.0%	11.5%
White persons not Hispanic, percent, 2011	91.7%	83.6%
Living in same house 1 year & over, 2006-2010	82.3%	81.1%
Foreign born persons, percent, 2006-2010	2.6%	5.9%
Language other than English spoken at home, pct age 5+, 2006-2010	3.8%	10.2%
High school graduates, percent of persons age 25+, 2006-2010	91.4%	88.2%
Bachelor's degree or higher, pct of persons age 25+, 2006-2010	23.2%	24.3%
Veterans, 2006-2010	14,027	130,011
Mean travel time to work (minutes), workers age 16+, 2006-2010	21.4	20.1
Housing units, 2010	63,177	667,796
Homeownership rate, 2006-2010	70.7%	71.0%
Housing units in multi-unit structures, percent, 2006-2010	15.0%	14.9%
Median value of owner-occupied housing units, 2006-2010	$220,000	$172,700
Households, 2006-2010	54,560	570,283
Persons per household, 2006-2010	2.45	2.63
Per capita money income in past 12 months (2010 dollars) 2006-2010	$24,418	$22,518
Median household income 2006-2010	$46,336	$46,423
Persons below poverty level, percent, 2006-2010	11.9%	13.6%

Business QuickFacts	Kootenai County	Idaho
Private nonfarm establishments, 2009	4,510	44,300[1]
Private nonfarm employment, 2009	44,289	500,226[1]
Private nonfarm employment, percent change 2000-2009	19.7%	11.0%[1]
Nonemployer establishments, 2009	10,199	107,029
Total number of firms, 2007	15,155	151,671
Black-owned firms, percent, 2007	0.2%	0.2%
American Indian- and Alaska Native-owned firms, percent, 2007	1.2%	0.9%
Asian-owned firms, percent, 2007	0.6%	0.8%

Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	F	S
Hispanic-owned firms, percent, 2007	1.8%	2.6%
Women-owned firms, percent, 2007	24.1%	23.5%
Manufacturers shipments, 2007 ($1000)	992,158	18,010,976
Merchant wholesaler sales, 2007 ($1000)	843,286	14,286,715
Retail sales, 2007 ($1000)	2,175,172	20,526,631
Retail sales per capita, 2007	$16,242	$13,691
Accommodation and food services sales, 2007 ($1000)	303,725	2,415,951
Building permits, 2011	623	3,815
Federal spending, 2010	1,486,375	14,251,733[1]

Geography QuickFacts	**Kootenai County**	**Idaho**
Land area in square miles, 2010	1,244.13	82,643.12
Persons per square mile, 2010	111.3	19.0
FIPS Code	055	16
Metropolitan or Micropolitan Statistical Area	Coeur d'Alene, ID Metro Area	

1: Includes data not distributed by county.

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.

D: Suppressed to avoid disclosure of confidential information
F: Fewer than 100 firms
FN: Footnote on this item for this area in place of data
NA: Not available
S: Suppressed; does not meet publication standards
X: Not applicable
Z: Value greater than zero but less than half unit of measure shown

Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, American Community Survey, Census of Population and Housing, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits, Consolidated Federal Funds Report
Last Revised: Thursday, 07-Jun-2012 13:32:08 EDT

Appendix C-1

Lagoon Water Balance 2018 - 2037

James A. Sewell & Associates, LLC

Growth Rate 4%

Year	Lagoon Storage Available (MG)	Required Lagoon Storage (MG)	Lagoon Storage Shortage (MG)	Irrigation System Capacity (MG)	Required Irrigation Volume (MG)	Excess, Unable to Irrigate (MG)
2017	44.03	40.66		68.14	59.92	
2018	44.03	41.74		78.98	62.08	
2019	44.03	42.07		84.12	64.33	
2020	44.03	45.47	-1.44	73.34	66.66	
2021	44.03	46.88	-2.85	73.34	69.09	
2022	44.03	46.90	-2.87	80.93	71.62	
2023	44.03	48.42	-4.39	81.37	74.24	
2024	44.03	49.41	-5.38	84.55	76.97	
2025	44.03	52.03	-8.00	79.41	79.81	0.41
2026	44.03	53.75	-9.72	79.41	82.77	3.36
2027	44.03	54.56	-10.53	84.55	85.84	1.29
2028	44.03	58.45	-14.42	74.21	89.04	14.83
2029	44.03	60.38	-16.35	74.21	92.36	18.15
2030	44.03	60.95	-16.92	81.80	95.82	14.02
2031	44.03	63.03	-19.01	81.80	99.41	17.61
2032	44.03	64.60	-20.57	84.99	103.15	18.17
2033	44.03	67.83	-23.80	80.28	107.04	26.76
2034	44.03	70.18	-26.15	80.28	111.08	30.81
2035	44.03	71.64	-27.62	85.42	115.29	29.87
2036	44.03	76.23	-32.20	74.64	119.66	45.02
2037	44.03	78.87	-34.84	74.64	124.21	49.57

Field Rotation Schedule

	Field 1a	Field 1b	Field 2	Field 3	Field 4	Field 5
Acreage	44	21	13	2.5	11	15
Year						
2017	Alfalfa	Spring Grain	Alfalfa		Forest	
2018	Alfalfa	Spring Grain	Alfalfa	Seedling Forest, 0.25	Forest	Forest
2019	Alfalfa	Alfalfa	Alfalfa	Seedling Forest, 0.25	Forest	Forest
2020	Spring Grain	Alfalfa	Alfalfa	Seedling Forest, 0.25	Forest	Forest
2021	Spring Grain	Alfalfa	Alfalfa	Seedling Forest, 0.25	Forest	Forest
2022	Alfalfa	Alfalfa	Spring Grain	Seedling Forest, 0.25	Forest	Forest
2023	Alfalfa	Alfalfa	Spring Grain	Juvenile Forest, 0.50	Forest	Forest
2024	Alfalfa	Alfalfa	Alfalfa	Juvenile Forest, 0.50	Forest	Forest
2025	Alfalfa	Spring Grain	Alfalfa	Juvenile Forest, 0.50	Forest	Forest
2026	Alfalfa	Spring Grain	Alfalfa	Juvenile Forest, 0.50	Forest	Forest
2027	Alfalfa	Alfalfa	Alfalfa	Juvenile Forest, 0.50	Forest	Forest
2028	Spring Grain	Alfalfa	Alfalfa	Int. Forest, 0.75	Forest	Forest
2029	Spring Grain	Alfalfa	Alfalfa	Int. Forest, 0.75	Forest	Forest
2030	Alfalfa	Alfalfa	Spring Grain	Int. Forest, 0.75	Forest	Forest
2031	Alfalfa	Alfalfa	Spring Grain	Int. Forest, 0.75	Forest	Forest
2032	Alfalfa	Alfalfa	Alfalfa	Int. Forest, 0.75	Forest	Forest
2033	Alfalfa	Spring Grain	Alfalfa	Forest	Forest	Forest
2034	Alfalfa	Spring Grain	Alfalfa	Forest	Forest	Forest
2035	Alfalfa	Alfalfa	Alfalfa	Forest	Forest	Forest
2036	Spring Grain	Alfalfa	Alfalfa	Forest	Forest	Forest
2037	Spring Grain	Alfalfa	Alfalfa	Forest	Forest	Forest

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2018
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation 15.5 acres
Lagoon Surface Area All Cells, Evaporation 8.72 acres
Working Storage Volume (MG) 37.047 MG
Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	4.77	637,377	700,140	144,837	11.14
November	3.07	0.64	152,475	4.61	616,816	769,292	0	16.89
December	3.10	0.28	165,558	4.77	637,377	802,935	0	22.89
January	2.91	0.34	152,969	4.77	637,377	790,346	0	28.81
February	2.06	0.63	95,964	4.31	575,695	671,659	0	33.83
March	2.13	1.56	70,465	4.77	637,377	707,842	0	39.12
April	1.77	2.62	16,657	4.61	616,816	633,473	497,746	**40.14**
May	2.03	3.94	-10,497	4.77	637,377	626,880	1,528,009	33.40
June	1.89	4.33	-30,719	4.61	616,816	586,097	1,970,872	23.04
July	0.94	5.11	-108,861	4.77	637,377	528,516	3,229,956	2.84
August	1.02	4.72	-92,015	4.77	637,377	545,362	1,847,089	-6.90
September	1.18	3.13	-32,683	4.61	616,816	584,133	1,340,541	-12.56
	24.20	**29.05**	**3.31**	**56.13**		**59.44**	**78.98**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	4.77	637,377	722,541	144,837	11.30
November	4.28	0.53	224,038	4.61	616,816	840,854	0	17.59
December	3.13	0.18	170,412	4.77	637,377	807,789	0	23.63
January	3.54	0.27	190,632	4.77	637,377	828,008	0	29.83
February	2.36	0.53	116,009	4.31	575,695	691,704	0	35.00
March	2.43	1.39	92,725	4.77	637,377	730,102	0	40.46
April	2.25	2.37	51,577	4.61	616,816	668,393	497,746	**41.74**
May	2.19	3.55	10,850	4.77	637,377	648,227	1,528,009	35.16
June	2.14	3.73	2,339	4.61	616,816	619,155	1,970,872	25.05
July	1.02	4.47	-84,101	4.77	637,377	553,276	3,229,956	5.03
August	1.23	4.14	-61,840	4.77	637,377	575,537	1,847,089	-4.48
September	1.51	2.75	-2,087	4.61	616,816	614,729	1,340,541	-9.91
	28.46	**25.45**	**5.95**	**56.13**		**62.08**	**78.98**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2018						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		47.97	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				12.53	Spring Grain
Field 1b	0	Acres	Field 1b	21	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.43	New Forest
Alfalfa	**57**		**Spring Grain**	**21**		**Forest**	**26**		**78.98**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 57

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	4,767,216	0.70	144,837	1.08
November	4,613,435	0.00		0.00
December	4,767,216	0.00		0.00
January	4,767,216	0.00		0.00
February	4,305,873	0.00		0.00
March	4,767,216	0.00		0.00
April	4,613,435	1.89	391,060	2.92
May	4,767,216	5.11	1,057,310	7.91
June	4,613,435	4.68	968,339	7.24
July	4,767,216	8.31	1,719,422	12.86
August	4,767,216	5.34	1,104,899	8.26
September	4,613,435	4.97	1,028,343	7.69
Totals	**56,130,126**	**31.00**	**6,414,210**	**47.97**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 21

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	4,767,216	0.00	0	0.00
November	4,613,435	0.00		0.00
December	4,767,216	0.00		0.00
January	4,767,216	0.00		0.00
February	4,305,873	0.00		0.00
March	4,767,216	0.00		0.00
April	4,613,435	0.88	67,082	0.50
May	4,767,216	3.07	234,026	1.75
June	4,613,435	6.66	507,692	3.80
July	4,767,216	9.33	711,226	5.32
August	4,767,216	2.04	155,509	1.16
September	4,613,435	0.00	0	0.00
Totals	**56,130,126**	**21.98**	**1,675,535**	**12.53**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	4,767,216	0.00		0
November	4,613,435	0.00		0
December	4,767,216	0.00		0
January	4,767,216	0.00		0
February	4,305,873	0.00		0
March	4,767,216	0.00		0
April	4,613,435	0.41	38,696	0.29
May	4,767,216	2.45	231,137	1.73
June	4,613,435	5.12	483,226	3.61
July	4,767,216	8.27	780,523	5.84
August	4,767,216	6.07	572,887	4.28
September	4,613,435	3.23	304,847	2.28
Totals	**56,130,126**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	4,767,216	0.00		0
November	4,613,435	0.00		0
December	4,767,216	0.00		0
January	4,767,216	0.00		0
February	4,305,873	0.00		0
March	4,767,216	0.00		0
April	4,613,435	0.10	908	0.01
May	4,767,216	0.61	5,536	0.04
June	4,613,435	1.28	11,616	0.09
July	4,767,216	2.07	18,785	0.14
August	4,767,216	1.52	13,794	0.10
September	4,613,435	0.81	7,351	0.05
Totals	**56,130,126**	**6.39**	**57,082**	**0.43**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
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Lagoon Surface Area All Cells, Precipitation 15.5 acres

Lagoon Surface Area All Cells, Evaporation 8.72 acres

Working Storage Volume (MG) 37.047 MG

Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	4.96	662,872	725,635	198,198	10.93
November	3.07	0.64	152,475	4.80	641,489	793,964	0	16.87
December	3.10	0.28	165,558	4.96	662,872	828,430	0	23.06
January	2.91	0.34	152,969	4.96	662,872	815,841	0	29.16
February	2.06	0.63	95,964	4.48	598,723	694,687	0	34.36
March	2.13	1.56	70,465	4.96	662,872	733,337	0	39.84
April	1.77	2.62	16,657	4.80	641,489	658,146	574,738	**40.47**
May	2.03	3.94	-10,497	4.96	662,872	652,375	1,683,518	32.76
June	1.89	4.33	-30,719	4.80	641,489	610,770	1,819,937	23.71
July	0.94	5.11	-108,861	4.96	662,872	554,011	3,152,201	4.28
August	1.02	4.72	-92,015	4.96	662,872	570,857	2,098,648	-7.15
September	1.18	3.13	-32,683	4.80	641,489	608,806	1,719,404	-15.45
	24.20	**29.05**	**3.31**	**58.38**		**61.68**	**84.12**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	4.96	662,872	748,036	198,198	11.09
November	4.28	0.53	224,038	4.80	641,489	865,527	0	17.57
December	3.13	0.18	170,412	4.96	662,872	833,284	0	23.80
January	3.54	0.27	190,632	4.96	662,872	853,504	0	30.18
February	2.36	0.53	116,009	4.48	598,723	714,732	0	35.53
March	2.43	1.39	92,725	4.96	662,872	755,597	0	41.18
April	2.25	2.37	51,577	4.80	641,489	693,066	574,738	**42.07**
May	2.19	3.55	10,850	4.96	662,872	673,722	1,683,518	34.51
June	2.14	3.73	2,339	4.80	641,489	643,828	1,819,937	25.72
July	1.02	4.47	-84,101	4.96	662,872	578,771	3,152,201	6.47
August	1.23	4.14	-61,840	4.96	662,872	601,032	2,098,648	-4.73
September	1.51	2.75	-2,087	4.80	641,489	639,402	1,719,404	-12.81
	28.46	**25.45**	**5.95**	**58.38**		**64.33**	**84.12**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2019						Field 3	2.5	Acres		
Alfalfa				Spring Grain		**New Forest**	**2.5**		65.65	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				0.00	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.43	New Forest
Alfalfa	**78**		**Spring Grain**	**0**		**Forest**	**26**		**84.12**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 78

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	4,957,905	0.70	198,198	1.48
November	4,797,972	0.00		0.00
December	4,957,905	0.00		0.00
January	4,957,905	0.00		0.00
February	4,478,108	0.00		0.00
March	4,957,905	0.00		0.00
April	4,797,972	1.89	535,135	4.00
May	4,957,905	5.11	1,446,845	10.82
June	4,797,972	4.68	1,325,095	9.91
July	4,957,905	8.31	2,352,893	17.60
August	4,957,905	5.34	1,511,968	11.31
September	4,797,972	4.97	1,407,206	10.53
Totals	**58,375,331**	**31.00**	**8,777,340**	**65.65**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 0

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	4,957,905	0.00	0	0.00
November	4,797,972	0.00		0.00
December	4,957,905	0.00		0.00
January	4,957,905	0.00		0.00
February	4,478,108	0.00		0.00
March	4,957,905	0.00		0.00
April	4,797,972	0.88	0	0.00
May	4,957,905	3.07	0	0.00
June	4,797,972	6.66	0	0.00
July	4,957,905	9.33	0	0.00
August	4,957,905	2.04	0	0.00
September	4,797,972	0.00	0	0.00
Totals	**58,375,331**	**21.98**	**0**	**0.00**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	4,957,905	0.00		0
November	4,797,972	0.00		0
December	4,957,905	0.00		0
January	4,957,905	0.00		0
February	4,478,108	0.00		0
March	4,957,905	0.00		0
April	4,797,972	0.41	38,696	0.29
May	4,957,905	2.45	231,137	1.73
June	4,797,972	5.12	483,226	3.61
July	4,957,905	8.27	780,523	5.84
August	4,957,905	6.07	572,887	4.28
September	4,797,972	3.23	304,847	2.28
Totals	**58,375,331**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	4,957,905	0.00		0
November	4,797,972	0.00		0
December	4,957,905	0.00		0
January	4,957,905	0.00		0
February	4,478,108	0.00		0
March	4,957,905	0.00		0
April	4,797,972	0.10	908	0.01
May	4,957,905	0.61	5,536	0.04
June	4,797,972	1.28	11,616	0.09
July	4,957,905	2.07	18,785	0.14
August	4,957,905	1.52	13,794	0.10
September	4,797,972	0.81	7,351	0.05
Totals	**58,375,331**	**6.39**	**57,082**	**0.43**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
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Lagoon Surface Area All Cells, Precipitation 15.5 acres
Lagoon Surface Area All Cells, Evaporation 8.72 acres
Working Storage Volume (MG) 37.047 MG
Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	5.16	689,387	752,149	86,394	11.96
November	3.07	0.64	152,475	4.99	667,148	819,624	0	18.09
December	3.10	0.28	165,558	5.16	689,387	854,945	0	24.49
January	2.91	0.34	152,969	5.16	689,387	842,356	0	30.79
February	2.06	0.63	95,964	4.66	622,672	718,636	0	36.16
March	2.13	1.56	70,465	5.16	689,387	759,852	0	41.84
April	1.77	2.62	16,657	4.99	667,148	683,805	413,421	**43.87**
May	2.03	3.94	-10,497	5.16	689,387	678,890	1,357,689	38.79
June	1.89	4.33	-30,719	4.99	667,148	636,429	2,136,182	27.57
July	0.94	5.11	-108,861	5.16	689,387	580,526	3,315,116	7.12
August	1.02	4.72	-92,015	5.16	689,387	597,372	1,571,572	-0.17
September	1.18	3.13	-32,683	4.99	667,148	634,465	925,596	-2.34
	24.20	**29.05**	**3.31**	**60.71**		**64.02**	**73.34**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	5.16	689,387	774,551	86,394	12.13
November	4.28	0.53	224,038	4.99	667,148	891,186	0	18.79
December	3.13	0.18	170,412	5.16	689,387	859,799	0	25.23
January	3.54	0.27	190,632	5.16	689,387	880,018	0	31.81
February	2.36	0.53	116,009	4.66	622,672	738,681	0	37.33
March	2.43	1.39	92,725	5.16	689,387	782,112	0	43.18
April	2.25	2.37	51,577	4.99	667,148	718,726	413,421	**45.47**
May	2.19	3.55	10,850	5.16	689,387	700,237	1,357,689	40.55
June	2.14	3.73	2,339	4.99	667,148	669,488	2,136,182	29.58
July	1.02	4.47	-84,101	5.16	689,387	605,285	3,315,116	9.31
August	1.23	4.14	-61,840	5.16	689,387	627,547	1,571,572	2.25
September	1.51	2.75	-2,087	4.99	667,148	665,061	925,596	0.30
	28.46	**25.45**	**5.95**	**60.71**		**66.66**	**73.34**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2020						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a		Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.43	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**73.34**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	5,156,221	0.70	86,394	0.65
November	4,989,891	0.00		0.00
December	5,156,221	0.00		0.00
January	5,156,221	0.00		0.00
February	4,657,232	0.00		0.00
March	5,156,221	0.00		0.00
April	4,989,891	1.89	233,264	1.74
May	5,156,221	5.11	630,676	4.72
June	4,989,891	4.68	577,606	4.32
July	5,156,221	8.31	1,025,620	7.67
August	5,156,221	5.34	659,063	4.93
September	4,989,891	4.97	613,397	4.59
Totals	**60,710,344**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	5,156,221	0.00	0	0.00
November	4,989,891	0.00		0.00
December	5,156,221	0.00		0.00
January	5,156,221	0.00		0.00
February	4,657,232	0.00		0.00
March	5,156,221	0.00		0.00
April	4,989,891	0.88	140,554	1.05
May	5,156,221	3.07	490,340	3.67
June	4,989,891	6.66	1,063,735	7.96
July	5,156,221	9.33	1,490,188	11.15
August	5,156,221	2.04	325,829	2.44
September	4,989,891	0.00	0	0.00
Totals	**60,710,344**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,156,221	0.00		0
November	4,989,891	0.00		0
December	5,156,221	0.00		0
January	5,156,221	0.00		0
February	4,657,232	0.00		0
March	5,156,221	0.00		0
April	4,989,891	0.41	38,696	0.29
May	5,156,221	2.45	231,137	1.73
June	4,989,891	5.12	483,226	3.61
July	5,156,221	8.27	780,523	5.84
August	5,156,221	6.07	572,887	4.28
September	4,989,891	3.23	304,847	2.28
Totals	**60,710,344**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,156,221	0.00		0
November	4,989,891	0.00		0
December	5,156,221	0.00		0
January	5,156,221	0.00		0
February	4,657,232	0.00		0
March	5,156,221	0.00		0
April	4,989,891	0.10	908	0.01
May	5,156,221	0.61	5,536	0.04
June	4,989,891	1.28	11,616	0.09
July	5,156,221	2.07	18,785	0.14
August	5,156,221	1.52	13,794	0.10
September	4,989,891	0.81	7,351	0.05
Totals	**60,710,344**	**6.39**	**57,082**	**0.43**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2021
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	5.36	716,962	779,725	86,394	12.17
November	3.07	0.64	152,475	5.19	693,834	846,310	0	18.50
December	3.10	0.28	165,558	5.36	716,962	882,521	0	25.10
January	2.91	0.34	152,969	5.36	716,962	869,931	0	31.60
February	2.06	0.63	95,964	4.84	647,579	743,543	0	37.17
March	2.13	1.56	70,465	5.36	716,962	787,427	0	43.06
April	1.77	2.62	16,657	5.19	693,834	710,491	413,421	**45.28**
May	2.03	3.94	-10,497	5.36	716,962	706,465	1,357,689	40.41
June	1.89	4.33	-30,719	5.19	693,834	663,115	2,136,182	29.39
July	0.94	5.11	-108,861	5.36	716,962	608,101	3,315,116	9.14
August	1.02	4.72	-92,015	5.36	716,962	624,948	1,571,572	2.06
September	1.18	3.13	-32,683	5.19	693,834	661,151	925,596	0.08
	24.20	**29.05**	**3.31**	**63.14**		**66.45**	**73.34**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	5.36	716,962	802,126	86,394	12.34
November	4.28	0.53	224,038	5.19	693,834	917,872	0	19.20
December	3.13	0.18	170,412	5.36	716,962	887,374	0	25.84
January	3.54	0.27	190,632	5.36	716,962	907,594	0	32.63
February	2.36	0.53	116,009	4.84	647,579	763,588	0	38.34
March	2.43	1.39	92,725	5.36	716,962	809,688	0	44.39
April	2.25	2.37	51,577	5.19	693,834	745,412	413,421	**46.88**
May	2.19	3.55	10,850	5.36	716,962	727,812	1,357,689	42.16
June	2.14	3.73	2,339	5.19	693,834	696,174	2,136,182	31.39
July	1.02	4.47	-84,101	5.36	716,962	632,861	3,315,116	11.33
August	1.23	4.14	-61,840	5.36	716,962	655,122	1,571,572	4.48
September	1.51	2.75	-2,087	5.19	693,834	691,747	925,596	2.73
	28.46	**25.45**	**5.95**	**63.14**		**69.09**	**73.34**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2021						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a		Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.43	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**73.34**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	5,362,470	0.70	86,394	0.65
November	5,189,487	0.00		0.00
December	5,362,470	0.00		0.00
January	5,362,470	0.00		0.00
February	4,843,521	0.00		0.00
March	5,362,470	0.00		0.00
April	5,189,487	1.89	233,264	1.74
May	5,362,470	5.11	630,676	4.72
June	5,189,487	4.68	577,606	4.32
July	5,362,470	8.31	1,025,620	7.67
August	5,362,470	5.34	659,063	4.93
September	5,189,487	4.97	613,397	4.59
Totals	**63,138,758**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	5,362,470	0.00	0	0.00
November	5,189,487	0.00		0.00
December	5,362,470	0.00		0.00
January	5,362,470	0.00		0.00
February	4,843,521	0.00		0.00
March	5,362,470	0.00		0.00
April	5,189,487	0.88	140,554	1.05
May	5,362,470	3.07	490,340	3.67
June	5,189,487	6.66	1,063,735	7.96
July	5,362,470	9.33	1,490,188	11.15
August	5,362,470	2.04	325,829	2.44
September	5,189,487	0.00	0	0.00
Totals	**63,138,758**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,362,470	0.00		0
November	5,189,487	0.00		0
December	5,362,470	0.00		0
January	5,362,470	0.00		0
February	4,843,521	0.00		0
March	5,362,470	0.00		0
April	5,189,487	0.41	38,696	0.29
May	5,362,470	2.45	231,137	1.73
June	5,189,487	5.12	483,226	3.61
July	5,362,470	8.27	780,523	5.84
August	5,362,470	6.07	572,887	4.28
September	5,189,487	3.23	304,847	2.28
Totals	**63,138,758**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,362,470	0.00		0
November	5,189,487	0.00		0
December	5,362,470	0.00		0
January	5,362,470	0.00		0
February	4,843,521	0.00		0
March	5,362,470	0.00		0
April	5,189,487	0.10	908	0.01
May	5,362,470	0.61	5,536	0.04
June	5,189,487	1.28	11,616	0.09
July	5,362,470	2.07	18,785	0.14
August	5,362,470	1.52	13,794	0.10
September	5,189,487	0.81	7,351	0.05
Totals	**63,138,758**	**6.39**	**57,082**	**0.43**

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2022
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	5.58	745,641	808,403	165,165	11.79
November	3.07	0.64	152,475	5.40	721,588	874,063	0	18.33
December	3.10	0.28	165,558	5.58	745,641	911,199	0	25.15
January	2.91	0.34	152,969	5.58	745,641	898,610	0	31.87
February	2.06	0.63	95,964	5.04	673,482	769,446	0	37.62
March	2.13	1.56	70,465	5.58	745,641	816,106	0	43.73
April	1.77	2.62	16,657	5.40	721,588	738,244	527,076	**45.31**
May	2.03	3.94	-10,497	5.58	745,641	735,143	1,587,250	38.93
June	1.89	4.33	-30,719	5.40	721,588	690,869	1,913,373	29.79
July	0.94	5.11	-108,861	5.58	745,641	636,780	3,200,335	10.61
August	1.02	4.72	-92,015	5.58	745,641	653,626	1,942,921	0.97
September	1.18	3.13	-32,683	5.40	721,588	688,905	1,484,870	-4.98
	24.20	**29.05**	**3.31**	**65.66**		**68.97**	**80.93**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	5.58	745,641	830,805	165,165	11.96
November	4.28	0.53	224,038	5.40	721,588	945,626	0	19.03
December	3.13	0.18	170,412	5.58	745,641	916,053	0	25.88
January	3.54	0.27	190,632	5.58	745,641	936,272	0	32.89
February	2.36	0.53	116,009	5.04	673,482	789,491	0	38.79
March	2.43	1.39	92,725	5.58	745,641	838,366	0	45.06
April	2.25	2.37	51,577	5.40	721,588	773,165	527,076	**46.90**
May	2.19	3.55	10,850	5.58	745,641	756,491	1,587,250	40.69
June	2.14	3.73	2,339	5.40	721,588	723,927	1,913,373	31.79
July	1.02	4.47	-84,101	5.58	745,641	661,539	3,200,335	12.81
August	1.23	4.14	-61,840	5.58	745,641	683,801	1,942,921	3.39
September	1.51	2.75	-2,087	5.40	721,588	719,501	1,484,870	-2.34
	28.46	**25.45**	**5.95**	**65.66**		**71.62**	**80.93**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2022						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		54.71	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				7.76	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	0		Field 2	13	Acres	Field 5	15	Acres	0.43	New Forest
Alfalfa	**65**		**Spring Grain**	**13**		**Forest**	**26**		**80.93**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 65

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	5,576,969	0.70	165,165	1.24
November	5,397,066	0.00		0.00
December	5,576,969	0.00		0.00
January	5,576,969	0.00		0.00
February	5,037,262	0.00		0.00
March	5,576,969	0.00		0.00
April	5,397,066	1.89	445,946	3.34
May	5,576,969	5.11	1,205,705	9.02
June	5,397,066	4.68	1,104,246	8.26
July	5,576,969	8.31	1,960,745	14.67
August	5,576,969	5.34	1,259,973	9.42
September	5,397,066	4.97	1,172,672	8.77
Totals	**65,664,308**	**31.00**	**7,314,450**	**54.71**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 13

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	5,576,969	0.00	0	0.00
November	5,397,066	0.00		0.00
December	5,576,969	0.00		0.00
January	5,576,969	0.00		0.00
February	5,037,262	0.00		0.00
March	5,576,969	0.00		0.00
April	5,397,066	0.88	41,527	0.31
May	5,576,969	3.07	144,873	1.08
June	5,397,066	6.66	314,285	2.35
July	5,576,969	9.33	440,283	3.29
August	5,576,969	2.04	96,268	0.72
September	5,397,066	0.00	0	0.00
Totals	**65,664,308**	**21.98**	**1,037,236**	**7.76**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,576,969	0.00		0
November	5,397,066	0.00		0
December	5,576,969	0.00		0
January	5,576,969	0.00		0
February	5,037,262	0.00		0
March	5,576,969	0.00		0
April	5,397,066	0.41	38,696	0.29
May	5,576,969	2.45	231,137	1.73
June	5,397,066	5.12	483,226	3.61
July	5,576,969	8.27	780,523	5.84
August	5,576,969	6.07	572,887	4.28
September	5,397,066	3.23	304,847	2.28
Totals	**65,664,308**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,576,969	0.00		0
November	5,397,066	0.00		0
December	5,576,969	0.00		0
January	5,576,969	0.00		0
February	5,037,262	0.00		0
March	5,576,969	0.00		0
April	5,397,066	0.10	908	0.01
May	5,576,969	0.61	5,536	0.04
June	5,397,066	1.28	11,616	0.09
July	5,576,969	2.07	18,785	0.14
August	5,576,969	1.52	13,794	0.10
September	5,397,066	0.81	7,351	0.05
Totals	**65,664,308**	**6.39**	**57,082**	**0.43**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2023
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	5.80	775,466	838,229	165,165	12.02
November	3.07	0.64	152,475	5.61	750,451	902,927	0	18.77
December	3.10	0.28	165,558	5.80	775,466	941,025	0	25.81
January	2.91	0.34	152,969	5.80	775,466	928,435	0	32.75
February	2.06	0.63	95,964	5.24	700,421	796,385	0	38.71
March	2.13	1.56	70,465	5.80	775,466	845,931	0	45.04
April	1.77	2.62	16,657	5.61	750,451	767,108	528,029	**46.82**
May	2.03	3.94	-10,497	5.80	775,466	764,969	1,592,827	40.63
June	1.89	4.33	-30,719	5.61	750,451	719,732	1,924,989	31.62
July	0.94	5.11	-108,861	5.80	775,466	666,606	3,219,075	12.53
August	1.02	4.72	-92,015	5.80	775,466	683,452	1,956,670	3.00
September	1.18	3.13	-32,683	5.61	750,451	717,768	1,492,175	-2.79
	24.20	**29.05**	**3.31**	**68.29**		**71.60**	**81.37**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	5.80	775,466	860,630	165,165	12.18
November	4.28	0.53	224,038	5.61	750,451	974,489	0	19.47
December	3.13	0.18	170,412	5.80	775,466	945,878	0	26.55
January	3.54	0.27	190,632	5.80	775,466	966,098	0	33.77
February	2.36	0.53	116,009	5.24	700,421	816,430	0	39.88
March	2.43	1.39	92,725	5.80	775,466	868,192	0	46.37
April	2.25	2.37	51,577	5.61	750,451	802,029	528,029	**48.42**
May	2.19	3.55	10,850	5.80	775,466	786,316	1,592,827	42.39
June	2.14	3.73	2,339	5.61	750,451	752,790	1,924,989	33.62
July	1.02	4.47	-84,101	5.80	775,466	691,365	3,219,075	14.72
August	1.23	4.14	-61,840	5.80	775,466	713,626	1,956,670	5.42
September	1.51	2.75	-2,087	5.61	750,451	748,364	1,492,175	-0.14
	28.46	**25.45**	**5.95**	**68.29**		**74.24**	**81.37**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest			
2023						Field 3	2.5	Acres	Allowable Irrigated Volume (MG)	
	Alfalfa			Spring Grain		**New Forest**	**2.5**		54.71	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				7.76	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	0		Field 2	13	Acres	Field 5	15	Acres	0.87	New Forest
Alfalfa	**65**		**Spring Grain**	**13**		**Forest**	**26**		**81.37**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 65

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	5,800,047	0.70	165,165	1.24
November	5,612,949	0.00		0.00
December	5,800,047	0.00		0.00
January	5,800,047	0.00		0.00
February	5,238,752	0.00		0.00
March	5,800,047	0.00		0.00
April	5,612,949	1.89	445,946	3.34
May	5,800,047	5.11	1,205,705	9.02
June	5,612,949	4.68	1,104,246	8.26
July	5,800,047	8.31	1,960,745	14.67
August	5,800,047	5.34	1,259,973	9.42
September	5,612,949	4.97	1,172,672	8.77
Totals	**68,290,881**	**31.00**	**7,314,450**	**54.71**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 13

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	5,800,047	0.00	0	0.00
November	5,612,949	0.00		0.00
December	5,800,047	0.00		0.00
January	5,800,047	0.00		0.00
February	5,238,752	0.00		0.00
March	5,800,047	0.00		0.00
April	5,612,949	0.88	41,527	0.31
May	5,800,047	3.07	144,873	1.08
June	5,612,949	6.66	314,285	2.35
July	5,800,047	9.33	440,283	3.29
August	5,800,047	2.04	96,268	0.72
September	5,612,949	0.00	0	0.00
Totals	**68,290,881**	**21.98**	**1,037,236**	**7.76**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,800,047	0.00		0
November	5,612,949	0.00		0
December	5,800,047	0.00		0
January	5,800,047	0.00		0
February	5,238,752	0.00		0
March	5,800,047	0.00		0
April	5,612,949	0.41	38,696	0.29
May	5,800,047	2.45	231,137	1.73
June	5,612,949	5.12	483,226	3.61
July	5,800,047	8.27	780,523	5.84
August	5,800,047	6.07	572,887	4.28
September	5,612,949	3.23	304,847	2.28
Totals	**68,290,881**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	5,800,047	0.00		0
November	5,612,949	0.00		0
December	5,800,047	0.00		0
January	5,800,047	0.00		0
February	5,238,752	0.00		0
March	5,800,047	0.00		0
April	5,612,949	0.21	1,860	0.01
May	5,800,047	1.22	11,112	0.08
June	5,612,949	2.56	23,232	0.17
July	5,800,047	4.14	37,525	0.28
August	5,800,047	3.04	27,543	0.21
September	5,612,949	1.62	14,656	0.11
Totals	**68,290,881**	**12.77**	**114,068**	**0.87**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2024
BY: KAK
Date: 1/19/2018

				Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Lagoon Surface Area All Cells, Precipitation	15.5	acres	Cell no. 2	0' - 2'	1.216	7.595	6.379
Lagoon Surface Area All Cells, Evaporation	8.72	acres	Cell no. 3	0'-4'	1.459	7.259	5.800
Working Storage Volume (MG)	37.047	MG	Cell no. 4	0'-4'	4.307	29.175	24.868
Year End Volume (MG)	6.982	MG	Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	6.03	806,485	869,248	198,198	12.00
November	3.07	0.64	152,475	5.84	780,469	932,945	0	18.98
December	3.10	0.28	165,558	6.03	806,485	972,043	0	26.25
January	2.91	0.34	152,969	6.03	806,485	959,454	0	33.43
February	2.06	0.63	95,964	5.45	728,438	824,402	0	39.59
March	2.13	1.56	70,465	6.03	806,485	876,950	0	46.15
April	1.77	2.62	16,657	5.84	780,469	797,126	575,691	**47.81**
May	2.03	3.94	-10,497	6.03	806,485	795,988	1,689,094	41.13
June	1.89	4.33	-30,719	5.84	780,469	749,750	1,831,553	33.04
July	0.94	5.11	-108,861	6.03	806,485	697,624	3,170,941	14.54
August	1.02	4.72	-92,015	6.03	806,485	714,470	2,112,397	4.08
September	1.18	3.13	-32,683	5.84	780,469	747,786	1,726,709	-3.24
	24.20	**29.05**	**3.31**	**71.02**		**74.33**	**84.55**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	6.03	806,485	891,649	198,198	12.17
November	4.28	0.53	224,038	5.84	780,469	1,004,507	0	19.68
December	3.13	0.18	170,412	6.03	806,485	976,897	0	26.99
January	3.54	0.27	190,632	6.03	806,485	997,117	0	34.45
February	2.36	0.53	116,009	5.45	728,438	844,447	0	40.76
March	2.43	1.39	92,725	6.03	806,485	899,210	0	47.49
April	2.25	2.37	51,577	5.84	780,469	832,047	575,691	**49.41**
May	2.19	3.55	10,850	6.03	806,485	817,335	1,689,094	42.88
June	2.14	3.73	2,339	5.84	780,469	782,809	1,831,553	35.04
July	1.02	4.47	-84,101	6.03	806,485	722,384	3,170,941	16.73
August	1.23	4.14	-61,840	6.03	806,485	744,645	2,112,397	6.50
September	1.51	2.75	-2,087	5.84	780,469	778,382	1,726,709	-0.60
	28.46	**25.45**	**5.95**	**71.02**		**76.97**	**84.55**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2024						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		65.65	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				0.00	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.87	New Forest
Alfalfa	**78**		**Spring Grain**	**0**		**Forest**	**26**		**84.55**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 78

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	6,032,049	0.70	198,198	1.48
November	5,837,467	0.00		0.00
December	6,032,049	0.00		0.00
January	6,032,049	0.00		0.00
February	5,448,303	0.00		0.00
March	6,032,049	0.00		0.00
April	5,837,467	1.89	535,135	4.00
May	6,032,049	5.11	1,446,845	10.82
June	5,837,467	4.68	1,325,095	9.91
July	6,032,049	8.31	2,352,893	17.60
August	6,032,049	5.34	1,511,968	11.31
September	5,837,467	4.97	1,407,206	10.53
Totals	**71,022,516**	**31.00**	**8,777,340**	**65.65**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 0

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	6,032,049	0.00	0	0.00
November	5,837,467	0.00		0.00
December	6,032,049	0.00		0.00
January	6,032,049	0.00		0.00
February	5,448,303	0.00		0.00
March	6,032,049	0.00		0.00
April	5,837,467	0.88	0	0.00
May	6,032,049	3.07	0	0.00
June	5,837,467	6.66	0	0.00
July	6,032,049	9.33	0	0.00
August	6,032,049	2.04	0	0.00
September	5,837,467	0.00	0	0.00
Totals	**71,022,516**	**21.98**	**0**	**0.00**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,032,049	0.00		0
November	5,837,467	0.00		0
December	6,032,049	0.00		0
January	6,032,049	0.00		0
February	5,448,303	0.00		0
March	6,032,049	0.00		0
April	5,837,467	0.41	38,696	0.29
May	6,032,049	2.45	231,137	1.73
June	5,837,467	5.12	483,226	3.61
July	6,032,049	8.27	780,523	5.84
August	6,032,049	6.07	572,887	4.28
September	5,837,467	3.23	304,847	2.28
Totals	**71,022,516**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,032,049	0.00		0
November	5,837,467	0.00		0
December	6,032,049	0.00		0
January	6,032,049	0.00		0
February	5,448,303	0.00		0
March	6,032,049	0.00		0
April	5,837,467	0.21	1,860	0.01
May	6,032,049	1.22	11,112	0.08
June	5,837,467	2.56	23,232	0.17
July	6,032,049	4.14	37,525	0.28
August	6,032,049	3.04	27,543	0.21
September	5,837,467	1.62	14,656	0.11
Totals	**71,022,516**	**12.77**	**114,068**	**0.87**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2025
BY: KAK
Date: 1/19/2018

				Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Lagoon Surface Area All Cells, Precipitation	15.5	acres	Cell no. 2	0' - 2'	1.216	7.595	6.379
Lagoon Surface Area All Cells, Evaporation	8.72	acres	Cell no. 3	0'-4'	1.459	7.259	5.800
Working Storage Volume (MG)	37.047	MG	Cell no. 4	0'-4'	4.307	29.175	24.868
Year End Volume (MG)	6.982	MG	Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	6.27	838,744	901,507	144,837	12.64
November	3.07	0.64	152,475	6.07	811,688	964,163	0	19.85
December	3.10	0.28	165,558	6.27	838,744	1,004,303	0	27.36
January	2.91	0.34	152,969	6.27	838,744	991,713	0	34.78
February	2.06	0.63	95,964	5.67	757,576	853,540	0	41.17
March	2.13	1.56	70,465	6.27	838,744	909,209	0	47.97
April	1.77	2.62	16,657	6.07	811,688	828,345	498,698	**50.43**
May	2.03	3.94	-10,497	6.27	838,744	828,247	1,533,585	45.16
June	1.89	4.33	-30,719	6.07	811,688	780,969	1,982,488	36.17
July	0.94	5.11	-108,861	6.27	838,744	729,884	3,248,696	17.33
August	1.02	4.72	-92,015	6.27	838,744	746,730	1,860,838	9.00
September	1.18	3.13	-32,683	6.07	811,688	779,005	1,347,846	4.74
	24.20	**29.05**	**3.31**	**73.86**		**77.17**	**79.41**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	6.27	838,744	923,909	144,837	12.81
November	4.28	0.53	224,038	6.07	811,688	1,035,726	0	20.56
December	3.13	0.18	170,412	6.27	838,744	1,009,156	0	28.10
January	3.54	0.27	190,632	6.27	838,744	1,029,376	0	35.80
February	2.36	0.53	116,009	5.67	757,576	873,585	0	42.34
March	2.43	1.39	92,725	6.27	838,744	931,470	0	49.30
April	2.25	2.37	51,577	6.07	811,688	863,265	498,698	**52.03**
May	2.19	3.55	10,850	6.27	838,744	849,594	1,533,585	46.91
June	2.14	3.73	2,339	6.07	811,688	814,027	1,982,488	38.17
July	1.02	4.47	-84,101	6.27	838,744	754,643	3,248,696	19.52
August	1.23	4.14	-61,840	6.27	838,744	776,904	1,860,838	11.41
September	1.51	2.75	-2,087	6.07	811,688	809,601	1,347,846	7.39
	28.46	**25.45**	**5.95**	**73.86**		**79.81**	**79.41**	**MG**
						Year End Excess	**0.00**	**MG**

2025		
	Alfalfa	
Field 1a	44	Acres
Field 1b	0	Acres
Field 2	13	
Alfalfa	**57**	

	Spring Grain	
Field 1a	0	Acres
Field 1b	21	Acres
Field 2	0	Acres
Spring Grain	**21**	

	Forest	
Field 3	2.5	Acres
New Forest	**2.5**	
Field 4	11	Acres
Field 5	15	Acres
Forest	**26**	

Allowable Irrigated Volume (MG)	
47.97	Alfalfa
12.53	Spring Grain
18.04	Forest
0.87	New Forest
79.41	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 57

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	6,273,331	0.70	144,837	1.08
November	6,070,966	0.00		0.00
December	6,273,331	0.00		0.00
January	6,273,331	0.00		0.00
February	5,666,235	0.00		0.00
March	6,273,331	0.00		0.00
April	6,070,966	1.89	391,060	2.92
May	6,273,331	5.11	1,057,310	7.91
June	6,070,966	4.68	968,339	7.24
July	6,273,331	8.31	1,719,422	12.86
August	6,273,331	5.34	1,104,899	8.26
September	6,070,966	4.97	1,028,343	7.69
Totals	**73,863,417**	**31.00**	**6,414,210**	**47.97**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 21

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	6,273,331	0.00	0	0.00
November	6,070,966	0.00		0.00
December	6,273,331	0.00		0.00
January	6,273,331	0.00		0.00
February	5,666,235	0.00		0.00
March	6,273,331	0.00		0.00
April	6,070,966	0.88	67,082	0.50
May	6,273,331	3.07	234,026	1.75
June	6,070,966	6.66	507,692	3.80
July	6,273,331	9.33	711,226	5.32
August	6,273,331	2.04	155,509	1.16
September	6,070,966	0.00	0	0.00
Totals	**73,863,417**	**21.98**	**1,675,535**	**12.53**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,273,331	0.00		0
November	6,070,966	0.00		0
December	6,273,331	0.00		0
January	6,273,331	0.00		0
February	5,666,235	0.00		0
March	6,273,331	0.00		0
April	6,070,966	0.41	38,696	0.29
May	6,273,331	2.45	231,137	1.73
June	6,070,966	5.12	483,226	3.61
July	6,273,331	8.27	780,523	5.84
August	6,273,331	6.07	572,887	4.28
September	6,070,966	3.23	304,847	2.28
Totals	**73,863,417**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,273,331	0.00		0
November	6,070,966	0.00		0
December	6,273,331	0.00		0
January	6,273,331	0.00		0
February	5,666,235	0.00		0
March	6,273,331	0.00		0
April	6,070,966	0.21	1,860	0.01
May	6,273,331	1.22	11,112	0.08
June	6,070,966	2.56	23,232	0.17
July	6,273,331	4.14	37,525	0.28
August	6,273,331	3.04	27,543	0.21
September	6,070,966	1.62	14,656	0.11
Totals	**73,863,417**	**12.77**	**114,068**	**0.87**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2026
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	6.52	872,294	935,057	144,837	12.89
November	3.07	0.64	152,475	6.31	844,156	996,631	0	20.35
December	3.10	0.28	165,558	6.52	872,294	1,037,853	0	28.11
January	2.91	0.34	152,969	6.52	872,294	1,025,263	0	35.78
February	2.06	0.63	95,964	5.89	787,879	883,843	0	42.39
March	2.13	1.56	70,465	6.52	872,294	942,759	0	49.44
April	1.77	2.62	16,657	6.31	844,156	860,812	498,698	**52.15**
May	2.03	3.94	-10,497	6.52	872,294	861,797	1,533,585	47.12
June	1.89	4.33	-30,719	6.31	844,156	813,436	1,982,488	38.38
July	0.94	5.11	-108,861	6.52	872,294	763,433	3,248,696	19.79
August	1.02	4.72	-92,015	6.52	872,294	780,279	1,860,838	11.71
September	1.18	3.13	-32,683	6.31	844,156	811,473	1,347,846	7.70
	24.20	**29.05**	**3.31**	**76.82**		**80.12**	**79.41**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	6.52	872,294	957,458	144,837	13.06
November	4.28	0.53	224,038	6.31	844,156	1,068,193	0	21.05
December	3.13	0.18	170,412	6.52	872,294	1,042,706	0	28.85
January	3.54	0.27	190,632	6.52	872,294	1,062,926	0	36.80
February	2.36	0.53	116,009	5.89	787,879	903,888	0	43.56
March	2.43	1.39	92,725	6.52	872,294	965,020	0	50.78
April	2.25	2.37	51,577	6.31	844,156	895,733	498,698	**53.75**
May	2.19	3.55	10,850	6.52	872,294	883,144	1,533,585	48.88
June	2.14	3.73	2,339	6.31	844,156	846,495	1,982,488	40.38
July	1.02	4.47	-84,101	6.52	872,294	788,193	3,248,696	21.98
August	1.23	4.14	-61,840	6.52	872,294	810,454	1,860,838	14.13
September	1.51	2.75	-2,087	6.31	844,156	842,068	1,347,846	10.34
	28.46	**25.45**	**5.95**	**76.82**		**82.77**	**79.41**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2026						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		47.97	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				12.53	Spring Grain
Field 1b	0	Acres	Field 1b	21	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.87	New Forest
Alfalfa	**57**		**Spring Grain**	**21**		**Forest**	**26**		**79.41**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 57

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	6,524,265	0.70	144,837	1.08
November	6,313,804	0.00		0.00
December	6,524,265	0.00		0.00
January	6,524,265	0.00		0.00
February	5,892,884	0.00		0.00
March	6,524,265	0.00		0.00
April	6,313,804	1.89	391,060	2.92
May	6,524,265	5.11	1,057,310	7.91
June	6,313,804	4.68	968,339	7.24
July	6,524,265	8.31	1,719,422	12.86
August	6,524,265	5.34	1,104,899	8.26
September	6,313,804	4.97	1,028,343	7.69
Totals	**76,817,953**	**31.00**	**6,414,210**	**47.97**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 21

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	6,524,265	0.00	0	0.00
November	6,313,804	0.00		0.00
December	6,524,265	0.00		0.00
January	6,524,265	0.00		0.00
February	5,892,884	0.00		0.00
March	6,524,265	0.00		0.00
April	6,313,804	0.88	67,082	0.50
May	6,524,265	3.07	234,026	1.75
June	6,313,804	6.66	507,692	3.80
July	6,524,265	9.33	711,226	5.32
August	6,524,265	2.04	155,509	1.16
September	6,313,804	0.00	0	0.00
Totals	**76,817,953**	**21.98**	**1,675,535**	**12.53**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,524,265	0.00		0
November	6,313,804	0.00		0
December	6,524,265	0.00		0
January	6,524,265	0.00		0
February	5,892,884	0.00		0
March	6,524,265	0.00		0
April	6,313,804	0.41	38,696	0.29
May	6,524,265	2.45	231,137	1.73
June	6,313,804	5.12	483,226	3.61
July	6,524,265	8.27	780,523	5.84
August	6,524,265	6.07	572,887	4.28
September	6,313,804	3.23	304,847	2.28
Totals	**76,817,953**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,524,265	0.00		0
November	6,313,804	0.00		0
December	6,524,265	0.00		0
January	6,524,265	0.00		0
February	5,892,884	0.00		0
March	6,524,265	0.00		0
April	6,313,804	0.21	1,860	0.01
May	6,524,265	1.22	11,112	0.08
June	6,313,804	2.56	23,232	0.17
July	6,524,265	4.14	37,525	0.28
August	6,524,265	3.04	27,543	0.21
September	6,313,804	1.62	14,656	0.11
Totals	**76,817,953**	**12.77**	**114,068**	**0.87**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2027
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation 15.5 acres

Lagoon Surface Area All Cells, Evaporation 8.72 acres

Working Storage Volume (MG) 37.047 MG

Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	6.79	907,186	969,949	198,198	12.75
November	3.07	0.64	152,475	6.57	877,922	1,030,397	0	20.46
December	3.10	0.28	165,558	6.79	907,186	1,072,744	0	28.48
January	2.91	0.34	152,969	6.79	907,186	1,060,155	0	36.41
February	2.06	0.63	95,964	6.13	819,394	915,358	0	43.26
March	2.13	1.56	70,465	6.79	907,186	977,651	0	50.57
April	1.77	2.62	16,657	6.57	877,922	894,578	575,691	**52.96**
May	2.03	3.94	-10,497	6.79	907,186	896,689	1,689,094	47.03
June	1.89	4.33	-30,719	6.57	877,922	847,203	1,831,553	39.67
July	0.94	5.11	-108,861	6.79	907,186	798,325	3,170,941	21.92
August	1.02	4.72	-92,015	6.79	907,186	815,171	2,112,397	12.22
September	1.18	3.13	-32,683	6.57	877,922	845,239	1,726,709	5.63
	24.20	**29.05**	**3.31**	**79.89**		**83.20**	**84.55**	**MG**
						Year End Excess	**0.00**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	6.79	907,186	992,350	198,198	12.92
November	4.28	0.53	224,038	6.57	877,922	1,101,960	0	21.16
December	3.13	0.18	170,412	6.79	907,186	1,077,598	0	29.22
January	3.54	0.27	190,632	6.79	907,186	1,097,818	0	37.43
February	2.36	0.53	116,009	6.13	819,394	935,403	0	44.43
March	2.43	1.39	92,725	6.79	907,186	999,911	0	51.91
April	2.25	2.37	51,577	6.57	877,922	929,499	575,691	**54.56**
May	2.19	3.55	10,850	6.79	907,186	918,036	1,689,094	48.79
June	2.14	3.73	2,339	6.57	877,922	880,261	1,831,553	41.67
July	1.02	4.47	-84,101	6.79	907,186	823,085	3,170,941	24.11
August	1.23	4.14	-61,840	6.79	907,186	845,346	2,112,397	14.64
September	1.51	2.75	-2,087	6.57	877,922	875,835	1,726,709	8.27
	28.46	**25.45**	**5.95**	**79.89**		**85.84**	**84.55**	**MG**
						Year End Excess	**0.00**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2027						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		65.65	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				0.00	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	0.87	New Forest
Alfalfa	**78**		**Spring Grain**	**0**		**Forest**	**26**		**84.55**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 78

		IWR		
Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	6,785,235	0.70	198,198	1.48
November	6,566,357	0.00		0.00
December	6,785,235	0.00		0.00
January	6,785,235	0.00		0.00
February	6,128,599	0.00		0.00
March	6,785,235	0.00		0.00
April	6,566,357	1.89	535,135	4.00
May	6,785,235	5.11	1,446,845	10.82
June	6,566,357	4.68	1,325,095	9.91
July	6,785,235	8.31	2,352,893	17.60
August	6,785,235	5.34	1,511,968	11.31
September	6,566,357	4.97	1,407,206	10.53
Totals	**79,890,671**	**31.00**	**8,777,340**	**65.65**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 0

		IWR		
Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	6,785,235	0.00	0	0.00
November	6,566,357	0.00		0.00
December	6,785,235	0.00		0.00
January	6,785,235	0.00		0.00
February	6,128,599	0.00		0.00
March	6,785,235	0.00		0.00
April	6,566,357	0.88	0	0.00
May	6,785,235	3.07	0	0.00
June	6,566,357	6.66	0	0.00
July	6,785,235	9.33	0	0.00
August	6,785,235	2.04	0	0.00
September	6,566,357	0.00	0	0.00
Totals	**79,890,671**	**21.98**	**0**	**0.00**

Forest Crop

Crop Acreage = 26

		IWR		
Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,785,235	0.00		0
November	6,566,357	0.00		0
December	6,785,235	0.00		0
January	6,785,235	0.00		0
February	6,128,599	0.00		0
March	6,785,235	0.00		0
April	6,566,357	0.41	38,696	0.29
May	6,785,235	2.45	231,137	1.73
June	6,566,357	5.12	483,226	3.61
July	6,785,235	8.27	780,523	5.84
August	6,785,235	6.07	572,887	4.28
September	6,566,357	3.23	304,847	2.28
Totals	**79,890,671**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

		IWR		
Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	6,785,235	0.00		0
November	6,566,357	0.00		0
December	6,785,235	0.00		0
January	6,785,235	0.00		0
February	6,128,599	0.00		0
March	6,785,235	0.00		0
April	6,566,357	0.21	1,860	0.01
May	6,785,235	1.22	11,112	0.08
June	6,566,357	2.56	23,232	0.17
July	6,785,235	4.14	37,525	0.28
August	6,785,235	3.04	27,543	0.21
September	6,566,357	1.62	14,656	0.11
Totals	**79,890,671**	**12.77**	**114,068**	**0.87**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2028
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	7.06	943,473	1,006,236	86,394	13.86
November	3.07	0.64	152,475	6.83	913,039	1,065,514	0	21.83
December	3.10	0.28	165,558	7.06	943,473	1,109,032	0	30.13
January	2.91	0.34	152,969	7.06	943,473	1,096,442	0	38.33
February	2.06	0.63	95,964	6.37	852,169	948,134	0	45.42
March	2.13	1.56	70,465	7.06	943,473	1,013,938	0	53.00
April	1.77	2.62	16,657	6.83	913,039	929,695	415,304	**56.85**
May	2.03	3.94	-10,497	7.06	943,473	932,976	1,368,822	53.59
June	1.89	4.33	-30,719	6.83	913,039	882,320	2,159,414	44.04
July	0.94	5.11	-108,861	7.06	943,473	834,613	3,352,618	25.20
August	1.02	4.72	-92,015	7.06	943,473	851,459	1,599,092	19.61
September	1.18	3.13	-32,683	6.83	913,039	880,356	940,229	19.16
	24.20	**29.05**	**3.31**	**83.09**		**86.39**	**74.21**	**MG**
						Year End Excess	**12.18**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	7.06	943,473	1,028,638	86,394	14.03
November	4.28	0.53	224,038	6.83	913,039	1,137,077	0	22.53
December	3.13	0.18	170,412	7.06	943,473	1,113,885	0	30.87
January	3.54	0.27	190,632	7.06	943,473	1,134,105	0	39.35
February	2.36	0.53	116,009	6.37	852,169	968,178	0	46.59
March	2.43	1.39	92,725	7.06	943,473	1,036,199	0	54.34
April	2.25	2.37	51,577	6.83	913,039	964,616	415,304	**58.45**
May	2.19	3.55	10,850	7.06	943,473	954,323	1,368,822	55.35
June	2.14	3.73	2,339	6.83	913,039	915,378	2,159,414	46.04
July	1.02	4.47	-84,101	7.06	943,473	859,372	3,352,618	27.40
August	1.23	4.14	-61,840	7.06	943,473	881,633	1,599,092	22.03
September	1.51	2.75	-2,087	6.83	913,039	910,951	940,229	21.81
	28.46	**25.45**	**5.95**	**83.09**		**89.04**	**74.21**	**MG**
						Year End Excess	**14.83**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2028						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a	0	Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.30	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**74.21**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	7,056,645	0.70	86,394	0.65
November	6,829,011	0.00		0.00
December	7,056,645	0.00		0.00
January	7,056,645	0.00		0.00
February	6,373,743	0.00		0.00
March	7,056,645	0.00		0.00
April	6,829,011	1.89	233,264	1.74
May	7,056,645	5.11	630,676	4.72
June	6,829,011	4.68	577,606	4.32
July	7,056,645	8.31	1,025,620	7.67
August	7,056,645	5.34	659,063	4.93
September	6,829,011	4.97	613,397	4.59
Totals	**83,086,298**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	7,056,645	0.00	0	0.00
November	6,829,011	0.00		0.00
December	7,056,645	0.00		0.00
January	7,056,645	0.00		0.00
February	6,373,743	0.00		0.00
March	7,056,645	0.00		0.00
April	6,829,011	0.88	140,554	1.05
May	7,056,645	3.07	490,340	3.67
June	6,829,011	6.66	1,063,735	7.96
July	7,056,645	9.33	1,490,188	11.15
August	7,056,645	2.04	325,829	2.44
September	6,829,011	0.00	0	0.00
Totals	**83,086,298**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,056,645	0.00		0
November	6,829,011	0.00		0
December	7,056,645	0.00		0
January	7,056,645	0.00		0
February	6,373,743	0.00		0
March	7,056,645	0.00		0
April	6,829,011	0.41	38,696	0.29
May	7,056,645	2.45	231,137	1.73
June	6,829,011	5.12	483,226	3.61
July	7,056,645	8.27	780,523	5.84
August	7,056,645	6.07	572,887	4.28
September	6,829,011	3.23	304,847	2.28
Totals	**83,086,298**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,056,645	0.00		0
November	6,829,011	0.00		0
December	7,056,645	0.00		0
January	7,056,645	0.00		0
February	6,373,743	0.00		0
March	7,056,645	0.00		0
April	6,829,011	0.31	2,791	0.02
May	7,056,645	1.84	16,669	0.12
June	6,829,011	3.84	34,848	0.26
July	7,056,645	6.20	56,288	0.42
August	7,056,645	4.55	41,314	0.31
September	6,829,011	2.42	21,984	0.16
Totals	**83,086,298**	**19.16**	**171,102**	**1.30**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2029
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	7.34	981,212	1,043,975	86,394	14.14
November	3.07	0.64	152,475	7.10	949,560	1,102,036	0	22.39
December	3.10	0.28	165,558	7.34	981,212	1,146,771	0	30.96
January	2.91	0.34	152,969	7.34	981,212	1,134,181	0	39.45
February	2.06	0.63	95,964	6.63	886,256	982,220	0	46.79
March	2.13	1.56	70,465	7.34	981,212	1,051,677	0	54.66
April	1.77	2.62	16,657	7.10	949,560	966,217	415,304	**58.78**
May	2.03	3.94	-10,497	7.34	981,212	970,715	1,368,822	55.80
June	1.89	4.33	-30,719	7.10	949,560	918,841	2,159,414	46.52
July	0.94	5.11	-108,861	7.34	981,212	872,352	3,352,618	27.97
August	1.02	4.72	-92,015	7.34	981,212	889,198	1,599,092	22.66
September	1.18	3.13	-32,683	7.10	949,560	916,877	940,229	22.49
	24.20	**29.05**	**3.31**	**86.41**		**89.72**	**74.21**	**MG**
						Year End Excess	**15.51**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	7.34	981,212	1,066,376	86,394	14.31
November	4.28	0.53	224,038	7.10	949,560	1,173,598	0	23.09
December	3.13	0.18	170,412	7.34	981,212	1,151,624	0	31.70
January	3.54	0.27	190,632	7.34	981,212	1,171,844	0	40.47
February	2.36	0.53	116,009	6.63	886,256	1,002,265	0	47.96
March	2.43	1.39	92,725	7.34	981,212	1,073,938	0	56.00
April	2.25	2.37	51,577	7.10	949,560	1,001,138	415,304	**60.38**
May	2.19	3.55	10,850	7.34	981,212	992,062	1,368,822	57.56
June	2.14	3.73	2,339	7.10	949,560	951,899	2,159,414	48.53
July	1.02	4.47	-84,101	7.34	981,212	897,111	3,352,618	30.16
August	1.23	4.14	-61,840	7.34	981,212	919,372	1,599,092	25.08
September	1.51	2.75	-2,087	7.10	949,560	947,473	940,229	25.13
	28.46	**25.45**	**5.95**	**86.41**		**92.36**	**74.21**	**MG**
						Year End Excess	**18.15**	**MG**

							Forest		Allowable Irrigated	
2029						Field 3	2.5	Acres	Volume (MG)	
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a	0	Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.30	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**74.21**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	7,338,910	0.70	86,394	0.65
November	7,102,171	0.00		0.00
December	7,338,910	0.00		0.00
January	7,338,910	0.00		0.00
February	6,628,693	0.00		0.00
March	7,338,910	0.00		0.00
April	7,102,171	1.89	233,264	1.74
May	7,338,910	5.11	630,676	4.72
June	7,102,171	4.68	577,606	4.32
July	7,338,910	8.31	1,025,620	7.67
August	7,338,910	5.34	659,063	4.93
September	7,102,171	4.97	613,397	4.59
Totals	**86,409,750**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	7,338,910	0.00	0	0.00
November	7,102,171	0.00		0.00
December	7,338,910	0.00		0.00
January	7,338,910	0.00		0.00
February	6,628,693	0.00		0.00
March	7,338,910	0.00		0.00
April	7,102,171	0.88	140,554	1.05
May	7,338,910	3.07	490,340	3.67
June	7,102,171	6.66	1,063,735	7.96
July	7,338,910	9.33	1,490,188	11.15
August	7,338,910	2.04	325,829	2.44
September	7,102,171	0.00	0	0.00
Totals	**86,409,750**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,338,910	0.00		0
November	7,102,171	0.00		0
December	7,338,910	0.00		0
January	7,338,910	0.00		0
February	6,628,693	0.00		0
March	7,338,910	0.00		0
April	7,102,171	0.41	38,696	0.29
May	7,338,910	2.45	231,137	1.73
June	7,102,171	5.12	483,226	3.61
July	7,338,910	8.27	780,523	5.84
August	7,338,910	6.07	572,887	4.28
September	7,102,171	3.23	304,847	2.28
Totals	**86,409,750**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,338,910	0.00		0
November	7,102,171	0.00		0
December	7,338,910	0.00		0
January	7,338,910	0.00		0
February	6,628,693	0.00		0
March	7,338,910	0.00		0
April	7,102,171	0.31	2,791	0.02
May	7,338,910	1.84	16,669	0.12
June	7,102,171	3.84	34,848	0.26
July	7,338,910	6.20	56,288	0.42
August	7,338,910	4.55	41,314	0.31
September	7,102,171	2.42	21,984	0.16
Totals	**86,409,750**	**19.16**	**171,102**	**1.30**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2030
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation 15.5 acres

Lagoon Surface Area All Cells, Evaporation 8.72 acres
Working Storage Volume (MG) 37.047 MG

Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	7.63	1,020,461	1,083,223	165,165	13.85
November	3.07	0.64	152,475	7.39	987,543	1,140,018	0	22.38
December	3.10	0.28	165,558	7.63	1,020,461	1,186,019	0	31.25
January	2.91	0.34	152,969	7.63	1,020,461	1,173,430	0	40.02
February	2.06	0.63	95,964	6.89	921,707	1,017,671	0	47.63
March	2.13	1.56	70,465	7.63	1,020,461	1,090,926	0	55.79
April	1.77	2.62	16,657	7.39	987,543	1,004,199	528,959	**59.35**
May	2.03	3.94	-10,497	7.63	1,020,461	1,009,964	1,598,383	54.95
June	1.89	4.33	-30,719	7.39	987,543	956,823	1,936,605	47.62
July	0.94	5.11	-108,861	7.63	1,020,461	911,600	3,237,837	30.22
August	1.02	4.72	-92,015	7.63	1,020,461	928,446	1,970,441	22.43
September	1.18	3.13	-32,683	7.39	987,543	954,860	1,499,503	18.35
	24.20	**29.05**	**3.31**	**89.87**		**93.17**	**81.80**	**MG**
						Year End Excess	**11.37**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	7.63	1,020,461	1,105,625	165,165	14.02
November	4.28	0.53	224,038	7.39	987,543	1,211,581	0	23.08
December	3.13	0.18	170,412	7.63	1,020,461	1,190,873	0	31.99
January	3.54	0.27	190,632	7.63	1,020,461	1,211,092	0	41.04
February	2.36	0.53	116,009	6.89	921,707	1,037,716	0	48.80
March	2.43	1.39	92,725	7.63	1,020,461	1,113,186	0	57.13
April	2.25	2.37	51,577	7.39	987,543	1,039,120	528,959	**60.95**
May	2.19	3.55	10,850	7.63	1,020,461	1,031,311	1,598,383	56.71
June	2.14	3.73	2,339	7.39	987,543	989,882	1,936,605	49.62
July	1.02	4.47	-84,101	7.63	1,020,461	936,360	3,237,837	32.41
August	1.23	4.14	-61,840	7.63	1,020,461	958,621	1,970,441	24.84
September	1.51	2.75	-2,087	7.39	987,543	985,455	1,499,503	21.00
	28.46	**25.45**	**5.95**	**89.87**		**95.82**	**81.80**	**MG**
						Year End Excess	**14.02**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2030						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		54.71	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				7.76	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	0		Field 2	13	Acres	Field 5	15	Acres	1.30	New Forest
Alfalfa	**65**		**Spring Grain**	**13**		**Forest**	**26**		**81.80**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 65

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	7,632,467	0.70	165,165	1.24
November	7,386,258	0.00		0.00
December	7,632,467	0.00		0.00
January	7,632,467	0.00		0.00
February	6,893,841	0.00		0.00
March	7,632,467	0.00		0.00
April	7,386,258	1.89	445,946	3.34
May	7,632,467	5.11	1,205,705	9.02
June	7,386,258	4.68	1,104,246	8.26
July	7,632,467	8.31	1,960,745	14.67
August	7,632,467	5.34	1,259,973	9.42
September	7,386,258	4.97	1,172,672	8.77
Totals	**89,866,140**	**31.00**	**7,314,450**	**54.71**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 13

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	7,632,467	0.00	0	0.00
November	7,386,258	0.00		0.00
December	7,632,467	0.00		0.00
January	7,632,467	0.00		0.00
February	6,893,841	0.00		0.00
March	7,632,467	0.00		0.00
April	7,386,258	0.88	41,527	0.31
May	7,632,467	3.07	144,873	1.08
June	7,386,258	6.66	314,285	2.35
July	7,632,467	9.33	440,283	3.29
August	7,632,467	2.04	96,268	0.72
September	7,386,258	0.00	0	0.00
Totals	**89,866,140**	**21.98**	**1,037,236**	**7.76**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,632,467	0.00		0
November	7,386,258	0.00		0
December	7,632,467	0.00		0
January	7,632,467	0.00		0
February	6,893,841	0.00		0
March	7,632,467	0.00		0
April	7,386,258	0.41	38,696	0.29
May	7,632,467	2.45	231,137	1.73
June	7,386,258	5.12	483,226	3.61
July	7,632,467	8.27	780,523	5.84
August	7,632,467	6.07	572,887	4.28
September	7,386,258	3.23	304,847	2.28
Totals	**89,866,140**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,632,467	0.00		0
November	7,386,258	0.00		0
December	7,632,467	0.00		0
January	7,632,467	0.00		0
February	6,893,841	0.00		0
March	7,632,467	0.00		0
April	7,386,258	0.31	2,791	0.02
May	7,632,467	1.84	16,669	0.12
June	7,386,258	3.84	34,848	0.26
July	7,632,467	6.20	56,288	0.42
August	7,632,467	4.55	41,314	0.31
September	7,386,258	2.42	21,984	0.16
Totals	**89,866,140**	**19.16**	**171,102**	**1.30**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2031
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation 15.5 acres
Lagoon Surface Area All Cells, Evaporation 8.72 acres
Working Storage Volume (MG) 37.047 MG
Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	7.94	1,061,279	1,124,042	165,165	14.15
November	3.07	0.64	152,475	7.68	1,027,044	1,179,520	0	22.98
December	3.10	0.28	165,558	7.94	1,061,279	1,226,838	0	32.15
January	2.91	0.34	152,969	7.94	1,061,279	1,214,248	0	41.23
February	2.06	0.63	95,964	7.17	958,575	1,054,539	0	49.12
March	2.13	1.56	70,465	7.94	1,061,279	1,131,744	0	57.59
April	1.77	2.62	16,657	7.68	1,027,044	1,043,701	528,959	**61.44**
May	2.03	3.94	-10,497	7.94	1,061,279	1,050,782	1,598,383	57.34
June	1.89	4.33	-30,719	7.68	1,027,044	996,325	1,936,605	50.31
July	0.94	5.11	-108,861	7.94	1,061,279	952,418	3,237,837	33.21
August	1.02	4.72	-92,015	7.94	1,061,279	969,265	1,970,441	25.73
September	1.18	3.13	-32,683	7.68	1,027,044	994,361	1,499,503	21.95
	24.20	**29.05**	**3.31**	**93.46**		**96.77**	**81.80**	**MG**
						Year End Excess	**14.97**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	7.94	1,061,279	1,146,443	165,165	14.32
November	4.28	0.53	224,038	7.68	1,027,044	1,251,082	0	23.68
December	3.13	0.18	170,412	7.94	1,061,279	1,231,691	0	32.89
January	3.54	0.27	190,632	7.94	1,061,279	1,251,911	0	42.25
February	2.36	0.53	116,009	7.17	958,575	1,074,584	0	50.29
March	2.43	1.39	92,725	7.94	1,061,279	1,154,005	0	58.92
April	2.25	2.37	51,577	7.68	1,027,044	1,078,622	528,959	**63.03**
May	2.19	3.55	10,850	7.94	1,061,279	1,072,129	1,598,383	59.10
June	2.14	3.73	2,339	7.68	1,027,044	1,029,384	1,936,605	52.31
July	1.02	4.47	-84,101	7.94	1,061,279	977,178	3,237,837	35.40
August	1.23	4.14	-61,840	7.94	1,061,279	999,439	1,970,441	28.14
September	1.51	2.75	-2,087	7.68	1,027,044	1,024,957	1,499,503	24.59
	28.46	**25.45**	**5.95**	**93.46**		**99.41**	**81.80**	**MG**
						Year End Excess	**17.61**	**MG**

2031		
	Alfalfa	
Field 1a	44	Acres
Field 1b	21	Acres
Field 2	0	
Alfalfa	**65**	

	Spring Grain	
Field 1a	0	Acres
Field 1b	0	Acres
Field 2	13	Acres
Spring Grain	**13**	

	Forest	
Field 3	2.5	Acres
New Forest	**2.5**	
Field 4	11	Acres
Field 5	15	Acres
Forest	**26**	

Allowable Irrigated Volume (MG)	
54.71	Alfalfa
7.76	Spring Grain
18.04	Forest
1.30	New Forest
81.80	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 65

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	7,937,765	0.70	165,165	1.24
November	7,681,708	0.00		0.00
December	7,937,765	0.00		0.00
January	7,937,765	0.00		0.00
February	7,169,595	0.00		0.00
March	7,937,765	0.00		0.00
April	7,681,708	1.89	445,946	3.34
May	7,937,765	5.11	1,205,705	9.02
June	7,681,708	4.68	1,104,246	8.26
July	7,937,765	8.31	1,960,745	14.67
August	7,937,765	5.34	1,259,973	9.42
September	7,681,708	4.97	1,172,672	8.77
Totals	**93,460,786**	**31.00**	**7,314,450**	**54.71**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 13

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	7,937,765	0.00	0	0.00
November	7,681,708	0.00		0.00
December	7,937,765	0.00		0.00
January	7,937,765	0.00		0.00
February	7,169,595	0.00		0.00
March	7,937,765	0.00		0.00
April	7,681,708	0.88	41,527	0.31
May	7,937,765	3.07	144,873	1.08
June	7,681,708	6.66	314,285	2.35
July	7,937,765	9.33	440,283	3.29
August	7,937,765	2.04	96,268	0.72
September	7,681,708	0.00	0	0.00
Totals	**93,460,786**	**21.98**	**1,037,236**	**7.76**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,937,765	0.00		0
November	7,681,708	0.00		0
December	7,937,765	0.00		0
January	7,937,765	0.00		0
February	7,169,595	0.00		0
March	7,937,765	0.00		0
April	7,681,708	0.41	38,696	0.29
May	7,937,765	2.45	231,137	1.73
June	7,681,708	5.12	483,226	3.61
July	7,937,765	8.27	780,523	5.84
August	7,937,765	6.07	572,887	4.28
September	7,681,708	3.23	304,847	2.28
Totals	**93,460,786**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	7,937,765	0.00		0
November	7,681,708	0.00		0
December	7,937,765	0.00		0
January	7,937,765	0.00		0
February	7,169,595	0.00		0
March	7,937,765	0.00		0
April	7,681,708	0.31	2,791	0.02
May	7,937,765	1.84	16,669	0.12
June	7,681,708	3.84	34,848	0.26
July	7,937,765	6.20	56,288	0.42
August	7,937,765	4.55	41,314	0.31
September	7,681,708	2.42	21,984	0.16
Totals	**93,460,786**	**19.16**	**171,102**	**1.30**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2032
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	8.26	1,103,730	1,166,493	198,198	14.22
November	3.07	0.64	152,475	7.99	1,068,126	1,220,601	0	23.35
December	3.10	0.28	165,558	8.26	1,103,730	1,269,289	0	32.85
January	2.91	0.34	152,969	8.26	1,103,730	1,256,699	0	42.25
February	2.06	0.63	95,964	7.46	996,918	1,092,882	0	50.42
March	2.13	1.56	70,465	8.26	1,103,730	1,174,195	0	59.20
April	1.77	2.62	16,657	7.99	1,068,126	1,084,783	576,621	**63.00**
May	2.03	3.94	-10,497	8.26	1,103,730	1,093,233	1,694,651	58.51
June	1.89	4.33	-30,719	7.99	1,068,126	1,037,407	1,843,169	52.48
July	0.94	5.11	-108,861	8.26	1,103,730	994,870	3,189,704	36.06
August	1.02	4.72	-92,015	8.26	1,103,730	1,011,716	2,126,168	27.73
September	1.18	3.13	-32,683	7.99	1,068,126	1,035,443	1,734,037	22.50
	24.20	**29.05**	**3.31**	**97.20**		**100.51**	**84.99**	**MG**
						Year End Excess	**15.52**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	8.26	1,103,730	1,188,895	198,198	14.39
November	4.28	0.53	224,038	7.99	1,068,126	1,292,164	0	24.06
December	3.13	0.18	170,412	8.26	1,103,730	1,274,142	0	33.59
January	3.54	0.27	190,632	8.26	1,103,730	1,294,362	0	43.27
February	2.36	0.53	116,009	7.46	996,918	1,112,927	0	51.59
March	2.43	1.39	92,725	8.26	1,103,730	1,196,456	0	60.54
April	2.25	2.37	51,577	7.99	1,068,126	1,119,703	576,621	**64.60**
May	2.19	3.55	10,850	8.26	1,103,730	1,114,580	1,694,651	60.26
June	2.14	3.73	2,339	7.99	1,068,126	1,070,465	1,843,169	54.48
July	1.02	4.47	-84,101	8.26	1,103,730	1,019,629	3,189,704	38.25
August	1.23	4.14	-61,840	8.26	1,103,730	1,041,890	2,126,168	30.14
September	1.51	2.75	-2,087	7.99	1,068,126	1,066,039	1,734,037	25.15
	28.46	**25.45**	**5.95**	**97.20**		**103.15**	**84.99**	**MG**
						Year End Excess	**18.17**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2032						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		65.65	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				0.00	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.30	New Forest
Alfalfa	**78**		**Spring Grain**	**0**		**Forest**	**26**		**84.99**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 78

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	8,255,276	0.70	198,198	1.48
November	7,988,977	0.00		0.00
December	8,255,276	0.00		0.00
January	8,255,276	0.00		0.00
February	7,456,378	0.00		0.00
March	8,255,276	0.00		0.00
April	7,988,977	1.89	535,135	4.00
May	8,255,276	5.11	1,446,845	10.82
June	7,988,977	4.68	1,325,095	9.91
July	8,255,276	8.31	2,352,893	17.60
August	8,255,276	5.34	1,511,968	11.31
September	7,988,977	4.97	1,407,206	10.53
Totals	**97,199,217**	**31.00**	**8,777,340**	**65.65**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 0

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	8,255,276	0.00	0	0.00
November	7,988,977	0.00		0.00
December	8,255,276	0.00		0.00
January	8,255,276	0.00		0.00
February	7,456,378	0.00		0.00
March	8,255,276	0.00		0.00
April	7,988,977	0.88	0	0.00
May	8,255,276	3.07	0	0.00
June	7,988,977	6.66	0	0.00
July	8,255,276	9.33	0	0.00
August	8,255,276	2.04	0	0.00
September	7,988,977	0.00	0	0.00
Totals	**97,199,217**	**21.98**	**0**	**0.00**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,255,276	0.00		0
November	7,988,977	0.00		0
December	8,255,276	0.00		0
January	8,255,276	0.00		0
February	7,456,378	0.00		0
March	8,255,276	0.00		0
April	7,988,977	0.41	38,696	0.29
May	8,255,276	2.45	231,137	1.73
June	7,988,977	5.12	483,226	3.61
July	8,255,276	8.27	780,523	5.84
August	8,255,276	6.07	572,887	4.28
September	7,988,977	3.23	304,847	2.28
Totals	**97,199,217**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,255,276	0.00		0
November	7,988,977	0.00		0
December	8,255,276	0.00		0
January	8,255,276	0.00		0
February	7,456,378	0.00		0
March	8,255,276	0.00		0
April	7,988,977	0.31	2,791	0.02
May	8,255,276	1.84	16,669	0.12
June	7,988,977	3.84	34,848	0.26
July	8,255,276	6.20	56,288	0.42
August	8,255,276	4.55	41,314	0.31
September	7,988,977	2.42	21,984	0.16
Totals	**97,199,217**	**19.16**	**171,102**	**1.30**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2033
BY: KAK
Date: 1/19/2018

Lagoon Surface Area All Cells, Precipitation 15.5 acres
Lagoon Surface Area All Cells, Evaporation 8.72 acres
Working Storage Volume (MG) 37.047 MG
Year End Volume (MG) 6.982 MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	8.59	1,147,880	1,210,642	144,837	14.95
November	3.07	0.64	152,475	8.31	1,110,851	1,263,326	0	24.40
December	3.10	0.28	165,558	8.59	1,147,880	1,313,438	0	34.23
January	2.91	0.34	152,969	8.59	1,147,880	1,300,849	0	43.96
February	2.06	0.63	95,964	7.75	1,036,794	1,132,759	0	52.43
March	2.13	1.56	70,465	8.59	1,147,880	1,218,344	0	61.54
April	1.77	2.62	16,657	8.31	1,110,851	1,127,508	500,559	**66.23**
May	2.03	3.94	-10,497	8.59	1,147,880	1,137,382	1,544,697	63.18
June	1.89	4.33	-30,719	8.31	1,110,851	1,080,132	2,005,720	56.26
July	0.94	5.11	-108,861	8.59	1,147,880	1,039,019	3,286,221	39.45
August	1.02	4.72	-92,015	8.59	1,147,880	1,055,865	1,888,380	33.23
September	1.18	3.13	-32,683	8.31	1,110,851	1,078,168	1,362,502	31.10
	24.20	**29.05**	**3.31**	**101.09**		**104.39**	**80.28**	**MG**
						Year End Excess	**24.12**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	8.59	1,147,880	1,233,044	144,837	15.12
November	4.28	0.53	224,038	8.31	1,110,851	1,334,889	0	25.11
December	3.13	0.18	170,412	8.59	1,147,880	1,318,291	0	34.97
January	3.54	0.27	190,632	8.59	1,147,880	1,338,511	0	44.98
February	2.36	0.53	116,009	7.75	1,036,794	1,152,803	0	53.60
March	2.43	1.39	92,725	8.59	1,147,880	1,240,605	0	62.88
April	2.25	2.37	51,577	8.31	1,110,851	1,162,428	500,559	**67.83**
May	2.19	3.55	10,850	8.59	1,147,880	1,158,730	1,544,697	64.94
June	2.14	3.73	2,339	8.31	1,110,851	1,113,190	2,005,720	58.27
July	1.02	4.47	-84,101	8.59	1,147,880	1,063,778	3,286,221	41.64
August	1.23	4.14	-61,840	8.59	1,147,880	1,086,040	1,888,380	35.64
September	1.51	2.75	-2,087	8.31	1,110,851	1,108,764	1,362,502	33.74
	28.46	**25.45**	**5.95**	**101.09**		**107.04**	**80.28**	**MG**
						Year End Excess	**26.76**	**MG**

2033		
	Alfalfa	
Field 1a	44	Acres
Field 1b	0	Acres
Field 2	13	
Alfalfa	**57**	

	Spring Grain	
Field 1a	0	Acres
Field 1b	21	Acres
Field 2	0	Acres
Spring Grain	**21**	

	Forest	
Field 3	2.5	Acres
New Forest	**2.5**	
Field 4	11	Acres
Field 5	15	Acres
Forest	**26**	

Allowable Irrigated Volume (MG)	
47.97	Alfalfa
12.53	Spring Grain
18.04	Forest
1.73	New Forest
80.28	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 57

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	8,585,487	0.70	144,837	1.08
November	8,308,536	0.00		0.00
December	8,585,487	0.00		0.00
January	8,585,487	0.00		0.00
February	7,754,633	0.00		0.00
March	8,585,487	0.00		0.00
April	8,308,536	1.89	391,060	2.92
May	8,585,487	5.11	1,057,310	7.91
June	8,308,536	4.68	968,339	7.24
July	8,585,487	8.31	1,719,422	12.86
August	8,585,487	5.34	1,104,899	8.26
September	8,308,536	4.97	1,028,343	7.69
Totals	**101,087,186**	**31.00**	**6,414,210**	**47.97**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 21

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	8,585,487	0.00	0	0.00
November	8,308,536	0.00		0.00
December	8,585,487	0.00		0.00
January	8,585,487	0.00		0.00
February	7,754,633	0.00		0.00
March	8,585,487	0.00		0.00
April	8,308,536	0.88	67,082	0.50
May	8,585,487	3.07	234,026	1.75
June	8,308,536	6.66	507,692	3.80
July	8,585,487	9.33	711,226	5.32
August	8,585,487	2.04	155,509	1.16
September	8,308,536	0.00	0	0.00
Totals	**101,087,186**	**21.98**	**1,675,535**	**12.53**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,585,487	0.00		0
November	8,308,536	0.00		0
December	8,585,487	0.00		0
January	8,585,487	0.00		0
February	7,754,633	0.00		0
March	8,585,487	0.00		0
April	8,308,536	0.41	38,696	0.29
May	8,585,487	2.45	231,137	1.73
June	8,308,536	5.12	483,226	3.61
July	8,585,487	8.27	780,523	5.84
August	8,585,487	6.07	572,887	4.28
September	8,308,536	3.23	304,847	2.28
Totals	**101,087,186**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,585,487	0.00		0
November	8,308,536	0.00		0
December	8,585,487	0.00		0
January	8,585,487	0.00		0
February	7,754,633	0.00		0
March	8,585,487	0.00		0
April	8,308,536	0.41	3,721	0.03
May	8,585,487	2.45	22,225	0.17
June	8,308,536	5.12	46,464	0.35
July	8,585,487	8.27	75,050	0.56
August	8,585,487	6.07	55,085	0.41
September	8,308,536	3.23	29,312	0.22
Totals	**101,087,186**	**25.55**	**228,136**	**1.73**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2034
BY: KAK
Date: 1/19/2018

				Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Lagoon Surface Area All Cells, Precipitation	15.5	acres	Cell no. 2	0' - 2'	1.216	7.595	6.379
Lagoon Surface Area All Cells, Evaporation	8.72	acres	Cell no. 3	0'-4'	1.459	7.259	5.800
Working Storage Volume (MG)	37.047	MG	Cell no. 4	0'-4'	4.307	29.175	24.868
Year End Volume (MG)	6.982	MG	Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	8.93	1,193,795	1,256,558	144,837	15.30
November	3.07	0.64	152,475	8.64	1,155,285	1,307,761	0	25.08
December	3.10	0.28	165,558	8.93	1,193,795	1,359,353	0	35.25
January	2.91	0.34	152,969	8.93	1,193,795	1,346,764	0	45.32
February	2.06	0.63	95,964	8.06	1,078,266	1,174,230	0	54.10
March	2.13	1.56	70,465	8.93	1,193,795	1,264,260	0	63.56
April	1.77	2.62	16,657	8.64	1,155,285	1,171,942	500,559	**68.58**
May	2.03	3.94	-10,497	8.93	1,193,795	1,183,298	1,544,697	65.88
June	1.89	4.33	-30,719	8.64	1,155,285	1,124,566	2,005,720	59.29
July	0.94	5.11	-108,861	8.93	1,193,795	1,084,934	3,286,221	42.82
August	1.02	4.72	-92,015	8.93	1,193,795	1,101,780	1,888,380	36.94
September	1.18	3.13	-32,683	8.64	1,155,285	1,122,602	1,362,502	35.14
	24.20	**29.05**	**3.31**	**105.13**		**108.44**	**80.28**	**MG**
						Year End Excess	**28.16**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	8.93	1,193,795	1,278,959	144,837	15.46
November	4.28	0.53	224,038	8.64	1,155,285	1,379,323	0	25.78
December	3.13	0.18	170,412	8.93	1,193,795	1,364,207	0	35.98
January	3.54	0.27	190,632	8.93	1,193,795	1,384,426	0	46.34
February	2.36	0.53	116,009	8.06	1,078,266	1,194,275	0	55.27
March	2.43	1.39	92,725	8.93	1,193,795	1,286,520	0	64.89
April	2.25	2.37	51,577	8.64	1,155,285	1,206,863	500,559	**70.18**
May	2.19	3.55	10,850	8.93	1,193,795	1,204,645	1,544,697	67.63
June	2.14	3.73	2,339	8.64	1,155,285	1,157,624	2,005,720	61.29
July	1.02	4.47	-84,101	8.93	1,193,795	1,109,694	3,286,221	45.01
August	1.23	4.14	-61,840	8.93	1,193,795	1,131,955	1,888,380	39.35
September	1.51	2.75	-2,087	8.64	1,155,285	1,153,198	1,362,502	37.79
	28.46	**25.45**	**5.95**	**105.13**		**111.08**	**80.28**	**MG**
						Year End Excess	**30.81**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2034						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		47.97	Alfalfa
Field 1a	44	Acres	Field 1a	0	Acres				12.53	Spring Grain
Field 1b	0	Acres	Field 1b	21	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.73	New Forest
Alfalfa	**57**		**Spring Grain**	**21**		**Forest**	**26**		**80.28**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 57

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	8,928,907	0.70	144,837	1.08
November	8,640,877	0.00		0.00
December	8,928,907	0.00		0.00
January	8,928,907	0.00		0.00
February	8,064,819	0.00		0.00
March	8,928,907	0.00		0.00
April	8,640,877	1.89	391,060	2.92
May	8,928,907	5.11	1,057,310	7.91
June	8,640,877	4.68	968,339	7.24
July	8,928,907	8.31	1,719,422	12.86
August	8,928,907	5.34	1,104,899	8.26
September	8,640,877	4.97	1,028,343	7.69
Totals	**105,130,673**	**31.00**	**6,414,210**	**47.97**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 21

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	8,928,907	0.00	0	0.00
November	8,640,877	0.00		0.00
December	8,928,907	0.00		0.00
January	8,928,907	0.00		0.00
February	8,064,819	0.00		0.00
March	8,928,907	0.00		0.00
April	8,640,877	0.88	67,082	0.50
May	8,928,907	3.07	234,026	1.75
June	8,640,877	6.66	507,692	3.80
July	8,928,907	9.33	711,226	5.32
August	8,928,907	2.04	155,509	1.16
September	8,640,877	0.00	0	0.00
Totals	**105,130,673**	**21.98**	**1,675,535**	**12.53**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,928,907	0.00		0
November	8,640,877	0.00		0
December	8,928,907	0.00		0
January	8,928,907	0.00		0
February	8,064,819	0.00		0
March	8,928,907	0.00		0
April	8,640,877	0.41	38,696	0.29
May	8,928,907	2.45	231,137	1.73
June	8,640,877	5.12	483,226	3.61
July	8,928,907	8.27	780,523	5.84
August	8,928,907	6.07	572,887	4.28
September	8,640,877	3.23	304,847	2.28
Totals	**105,130,673**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	8,928,907	0.00		0
November	8,640,877	0.00		0
December	8,928,907	0.00		0
January	8,928,907	0.00		0
February	8,064,819	0.00		0
March	8,928,907	0.00		0
April	8,640,877	0.41	3,721	0.03
May	8,928,907	2.45	22,225	0.17
June	8,640,877	5.12	46,464	0.35
July	8,928,907	8.27	75,050	0.56
August	8,928,907	6.07	55,085	0.41
September	8,640,877	3.23	29,312	0.22
Totals	**105,130,673**	**25.55**	**228,136**	**1.73**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

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BY: KAK
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				Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Lagoon Surface Area All Cells, Precipitation	15.5	acres	Cell no. 2	0' - 2'	1.216	7.595	6.379
Lagoon Surface Area All Cells, Evaporation	8.72	acres	Cell no. 3	0'-4'	1.459	7.259	5.800
Working Storage Volume (MG)	37.047	MG	Cell no. 4	0'-4'	4.307	29.175	24.868
Year End Volume (MG)	6.982	MG	Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	9.29	1,241,547	1,304,309	198,198	15.26
November	3.07	0.64	152,475	8.99	1,201,497	1,353,972	0	25.38
December	3.10	0.28	165,558	9.29	1,241,547	1,407,105	0	35.91
January	2.91	0.34	152,969	9.29	1,241,547	1,394,516	0	46.34
February	2.06	0.63	95,964	8.39	1,121,397	1,217,361	0	55.44
March	2.13	1.56	70,465	9.29	1,241,547	1,312,011	0	65.25
April	1.77	2.62	16,657	8.99	1,201,497	1,218,153	577,551	**70.05**
May	2.03	3.94	-10,497	9.29	1,241,547	1,231,049	1,700,207	66.54
June	1.89	4.33	-30,719	8.99	1,201,497	1,170,777	1,854,785	61.42
July	0.94	5.11	-108,861	9.29	1,241,547	1,132,686	3,208,466	45.90
August	1.02	4.72	-92,015	9.29	1,241,547	1,149,532	2,139,939	38.49
September	1.18	3.13	-32,683	8.99	1,201,497	1,168,814	1,741,365	34.21
	24.20	**29.05**	**3.31**	**109.34**		**112.64**	**85.42**	**MG**
						Year End Excess	**27.22**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	9.29	1,241,547	1,326,711	198,198	15.42
November	4.28	0.53	224,038	8.99	1,201,497	1,425,534	0	26.08
December	3.13	0.18	170,412	9.29	1,241,547	1,411,958	0	36.65
January	3.54	0.27	190,632	9.29	1,241,547	1,432,178	0	47.36
February	2.36	0.53	116,009	8.39	1,121,397	1,237,406	0	56.61
March	2.43	1.39	92,725	9.29	1,241,547	1,334,272	0	66.59
April	2.25	2.37	51,577	8.99	1,201,497	1,253,074	577,551	**71.64**
May	2.19	3.55	10,850	9.29	1,241,547	1,252,397	1,700,207	68.30
June	2.14	3.73	2,339	8.99	1,201,497	1,203,836	1,854,785	63.43
July	1.02	4.47	-84,101	9.29	1,241,547	1,157,445	3,208,466	48.09
August	1.23	4.14	-61,840	9.29	1,241,547	1,179,707	2,139,939	40.90
September	1.51	2.75	-2,087	8.99	1,201,497	1,199,409	1,741,365	36.85
	28.46	**25.45**	**5.95**	**109.34**		**115.29**	**85.42**	**MG**
						Year End Excess	**29.87**	**MG**

2035		
	Alfalfa	
Field 1a	44	Acres
Field 1b	21	Acres
Field 2	13	
Alfalfa	**78**	

	Spring Grain	
Field 1a	0	Acres
Field 1b	0	Acres
Field 2	0	Acres
Spring Grain	**0**	

	Forest	
Field 3	2.5	Acres
New Forest	**2.5**	
Field 4	11	Acres
Field 5	15	Acres
Forest	**26**	

Allowable Irrigated Volume (MG)	
65.65	Alfalfa
0.00	Spring Grain
18.04	Forest
1.73	New Forest
85.42	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 78

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	9,286,063	0.70	198,198	1.48
November	8,986,512	0.00		0.00
December	9,286,063	0.00		0.00
January	9,286,063	0.00		0.00
February	8,387,412	0.00		0.00
March	9,286,063	0.00		0.00
April	8,986,512	1.89	535,135	4.00
May	9,286,063	5.11	1,446,845	10.82
June	8,986,512	4.68	1,325,095	9.91
July	9,286,063	8.31	2,352,893	17.60
August	9,286,063	5.34	1,511,968	11.31
September	8,986,512	4.97	1,407,206	10.53
Totals	**109,335,900**	**31.00**	**8,777,340**	**65.65**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 0

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	9,286,063	0.00	0	0.00
November	8,986,512	0.00		0.00
December	9,286,063	0.00		0.00
January	9,286,063	0.00		0.00
February	8,387,412	0.00		0.00
March	9,286,063	0.00		0.00
April	8,986,512	0.88	0	0.00
May	9,286,063	3.07	0	0.00
June	8,986,512	6.66	0	0.00
July	9,286,063	9.33	0	0.00
August	9,286,063	2.04	0	0.00
September	8,986,512	0.00	0	0.00
Totals	**109,335,900**	**21.98**	**0**	**0.00**

Forest Crop

Crop Acreage = 26

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	9,286,063	0.00		0
November	8,986,512	0.00		0
December	9,286,063	0.00		0
January	9,286,063	0.00		0
February	8,387,412	0.00		0
March	9,286,063	0.00		0
April	8,986,512	0.41	38,696	0.29
May	9,286,063	2.45	231,137	1.73
June	8,986,512	5.12	483,226	3.61
July	9,286,063	8.27	780,523	5.84
August	9,286,063	6.07	572,887	4.28
September	8,986,512	3.23	304,847	2.28
Totals	**109,335,900**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

Month	Expected Monthly Flow Rate (gal/month)	IWR Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	9,286,063	0.00		0
November	8,986,512	0.00		0
December	9,286,063	0.00		0
January	9,286,063	0.00		0
February	8,387,412	0.00		0
March	9,286,063	0.00		0
April	8,986,512	0.41	3,721	0.03
May	9,286,063	2.45	22,225	0.17
June	8,986,512	5.12	46,464	0.35
July	9,286,063	8.27	75,050	0.56
August	9,286,063	6.07	55,085	0.41
September	8,986,512	3.23	29,312	0.22
Totals	**109,335,900**	**25.55**	**228,136**	**1.73**

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Lagoon Surface Area All Cells, Precipitation	15.5	acres
Lagoon Surface Area All Cells, Evaporation	8.72	acres
Working Storage Volume (MG)	37.047	MG
Year End Volume (MG)	6.982	MG

	Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Cell no. 2	0' - 2'	1.216	7.595	6.379
Cell no. 3	0'-4'	1.459	7.259	5.800
Cell no. 4	0'-4'	4.307	29.175	24.868
Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	9.66	1,291,208	1,353,971	86,394	16.46
November	3.07	0.64	152,475	9.35	1,249,557	1,402,032	0	26.95
December	3.10	0.28	165,558	9.66	1,291,208	1,456,767	0	37.84
January	2.91	0.34	152,969	9.66	1,291,208	1,444,177	0	48.65
February	2.06	0.63	95,964	8.72	1,166,253	1,262,217	0	58.09
March	2.13	1.56	70,465	9.66	1,291,208	1,361,673	0	68.27
April	1.77	2.62	16,657	9.35	1,249,557	1,266,213	416,234	**74.63**
May	2.03	3.94	-10,497	9.66	1,291,208	1,280,711	1,374,378	73.93
June	1.89	4.33	-30,719	9.35	1,249,557	1,218,837	2,171,030	66.81
July	0.94	5.11	-108,861	9.66	1,291,208	1,182,348	3,371,381	50.43
August	1.02	4.72	-92,015	9.66	1,291,208	1,199,194	1,612,863	47.34
September	1.18	3.13	-32,683	9.35	1,249,557	1,216,874	947,557	49.35
	24.20	**29.05**	**3.31**	**113.71**		**117.02**	**74.64**	**MG**
						Year End Excess	**42.37**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	9.66	1,291,208	1,376,373	86,394	16.63
November	4.28	0.53	224,038	9.35	1,249,557	1,473,594	0	27.65
December	3.13	0.18	170,412	9.66	1,291,208	1,461,620	0	38.58
January	3.54	0.27	190,632	9.66	1,291,208	1,481,840	0	49.67
February	2.36	0.53	116,009	8.72	1,166,253	1,282,262	0	59.26
March	2.43	1.39	92,725	9.66	1,291,208	1,383,934	0	69.61
April	2.25	2.37	51,577	9.35	1,249,557	1,301,134	416,234	**76.23**
May	2.19	3.55	10,850	9.66	1,291,208	1,302,059	1,374,378	75.69
June	2.14	3.73	2,339	9.35	1,249,557	1,251,896	2,171,030	68.81
July	1.02	4.47	-84,101	9.66	1,291,208	1,207,107	3,371,381	52.62
August	1.23	4.14	-61,840	9.66	1,291,208	1,229,369	1,612,863	49.76
September	1.51	2.75	-2,087	9.35	1,249,557	1,247,469	947,557	52.00
	28.46	**25.45**	**5.95**	**113.71**		**119.66**	**74.64**	**MG**
						Year End Excess	**45.02**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2036						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a	0	Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.73	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**74.64**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	9,657,505	0.70	86,394	0.65
November	9,345,973	0.00		0.00
December	9,657,505	0.00		0.00
January	9,657,505	0.00		0.00
February	8,722,908	0.00		0.00
March	9,657,505	0.00		0.00
April	9,345,973	1.89	233,264	1.74
May	9,657,505	5.11	630,676	4.72
June	9,345,973	4.68	577,606	4.32
July	9,657,505	8.31	1,025,620	7.67
August	9,657,505	5.34	659,063	4.93
September	9,345,973	4.97	613,397	4.59
Totals	**113,709,336**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	9,657,505	0.00	0	0.00
November	9,345,973	0.00		0.00
December	9,657,505	0.00		0.00
January	9,657,505	0.00		0.00
February	8,722,908	0.00		0.00
March	9,657,505	0.00		0.00
April	9,345,973	0.88	140,554	1.05
May	9,657,505	3.07	490,340	3.67
June	9,345,973	6.66	1,063,735	7.96
July	9,657,505	9.33	1,490,188	11.15
August	9,657,505	2.04	325,829	2.44
September	9,345,973	0.00	0	0.00
Totals	**113,709,336**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	9,657,505	0.00		0
November	9,345,973	0.00		0
December	9,657,505	0.00		0
January	9,657,505	0.00		0
February	8,722,908	0.00		0
March	9,657,505	0.00		0
April	9,345,973	0.41	38,696	0.29
May	9,657,505	2.45	231,137	1.73
June	9,345,973	5.12	483,226	3.61
July	9,657,505	8.27	780,523	5.84
August	9,657,505	6.07	572,887	4.28
September	9,345,973	3.23	304,847	2.28
Totals	**113,709,336**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	9,657,505	0.00		0
November	9,345,973	0.00		0
December	9,657,505	0.00		0
January	9,657,505	0.00		0
February	8,722,908	0.00		0
March	9,657,505	0.00		0
April	9,345,973	0.41	3,721	0.03
May	9,657,505	2.45	22,225	0.17
June	9,345,973	5.12	46,464	0.35
July	9,657,505	8.27	75,050	0.56
August	9,657,505	6.07	55,085	0.41
September	9,345,973	3.23	29,312	0.22
Totals	**113,709,336**	**25.55**	**228,136**	**1.73**

JAMES A. SEWELL & ASSOCIATES, LLC 2018 - January Facility Plan

Project: City of Spirit Lake
Ref: Lagoon Storage Requirements Year 2037
BY: KAK
Date: 1/19/2018

				Dead Storage Location	Dead Storage, (MG)	Total Storage Below Elevation 2067.00	Working Storage (MG)
Lagoon Surface Area All Cells, Precipitation	15.5	acres	Cell no. 2	0' - 2'	1.216	7.595	6.379
Lagoon Surface Area All Cells, Evaporation	8.72	acres	Cell no. 3	0'-4'	1.459	7.259	5.800
Working Storage Volume (MG)	37.047	MG	Cell no. 4	0'-4'	4.307	29.175	24.868
Year End Volume (MG)	6.982	MG	Total		6.982	44.029	37.047

LAGOON STORAGE

Month	Average Year Precipitation (1947-2012) (inches)	Evaporation (inches)	Average Year Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.10	1.75	62,763	10.04	1,342,857	1,405,619	86,394	16.85
November	3.07	0.64	152,475	9.72	1,299,539	1,452,014	0	27.71
December	3.10	0.28	165,558	10.04	1,342,857	1,508,415	0	38.99
January	2.91	0.34	152,969	10.04	1,342,857	1,495,826	0	50.18
February	2.06	0.63	95,964	9.07	1,212,903	1,308,867	0	59.97
March	2.13	1.56	70,465	10.04	1,342,857	1,413,322	0	70.54
April	1.77	2.62	16,657	9.72	1,299,539	1,316,195	416,234	**77.27**
May	2.03	3.94	-10,497	10.04	1,342,857	1,332,360	1,374,378	76.96
June	1.89	4.33	-30,719	9.72	1,299,539	1,268,820	2,171,030	70.21
July	0.94	5.11	-108,861	10.04	1,342,857	1,233,996	3,371,381	54.22
August	1.02	4.72	-92,015	10.04	1,342,857	1,250,842	1,612,863	51.51
September	1.18	3.13	-32,683	9.72	1,299,539	1,266,856	947,557	53.90
	24.20	**29.05**	**3.31**	**118.26**		**121.56**	**74.64**	**MG**
						Year End Excess	**46.92**	**MG**

LAGOON STORAGE - 20% P - 80% E

Month	20% Exceedance Precipitation (1947-2012) (inches)	80% Exceedance Evaporation (inches)	Precipitation Less Evaporation Volume (ft^3)	Monthly Design Influent (MG)	Monthly Design Influent (ft^3)	Monthly Storage Addition (ft^3)	Irrigation Volume (ft^3)	Total Required Storage Volume (MG)
October	2.38	1.54	85,164	10.04	1,342,857	1,428,021	86,394	17.02
November	4.28	0.53	224,038	9.72	1,299,539	1,523,577	0	28.41
December	3.13	0.18	170,412	10.04	1,342,857	1,513,269	0	39.73
January	3.54	0.27	190,632	10.04	1,342,857	1,533,488	0	51.20
February	2.36	0.53	116,009	9.07	1,212,903	1,328,912	0	61.14
March	2.43	1.39	92,725	10.04	1,342,857	1,435,582	0	71.88
April	2.25	2.37	51,577	9.72	1,299,539	1,351,116	416,234	**78.87**
May	2.19	3.55	10,850	10.04	1,342,857	1,353,707	1,374,378	78.71
June	2.14	3.73	2,339	9.72	1,299,539	1,301,878	2,171,030	72.21
July	1.02	4.47	-84,101	10.04	1,342,857	1,258,756	3,371,381	56.41
August	1.23	4.14	-61,840	10.04	1,342,857	1,281,017	1,612,863	53.93
September	1.51	2.75	-2,087	9.72	1,299,539	1,297,452	947,557	56.55
	28.46	**25.45**	**5.95**	**118.26**		**124.21**	**74.64**	**MG**
						Year End Excess	**49.57**	**MG**

							Forest		Allowable Irrigated Volume (MG)	
2037						Field 3	2.5	Acres		
	Alfalfa			Spring Grain		**New Forest**	**2.5**		28.62	Alfalfa
Field 1a	0	Acres	Field 1a	44	Acres				26.26	Spring Grain
Field 1b	21	Acres	Field 1b	0	Acres	Field 4	11	Acres	18.04	Forest
Field 2	13		Field 2	0	Acres	Field 5	15	Acres	1.73	New Forest
Alfalfa	**34**		**Spring Grain**	**44**		**Forest**	**26**		**74.64**	Total

Alfalfa Crop

Irrigation Efficiency 85% Crop Acreage = 34

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Alfalfa Crop (ft^3)	Irrigated Volume Alfalfa Crop (MG)
October	10,043,805	0.70	86,394	0.65
November	9,719,812	0.00		0.00
December	10,043,805	0.00		0.00
January	10,043,805	0.00		0.00
February	9,071,824	0.00		0.00
March	10,043,805	0.00		0.00
April	9,719,812	1.89	233,264	1.74
May	10,043,805	5.11	630,676	4.72
June	9,719,812	4.68	577,606	4.32
July	10,043,805	8.31	1,025,620	7.67
August	10,043,805	5.34	659,063	4.93
September	9,719,812	4.97	613,397	4.59
Totals	**118,257,710**	**31.00**	**3,826,020**	**28.62**

Spring Grain - Irrigated

Irrigation Efficiency 85% Crop Acreage = 44

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Spring Grain Crop (ft^3)	Irrigated Volume Spring Grain Crop (MG)
October	10,043,805	0.00	0	0.00
November	9,719,812	0.00		0.00
December	10,043,805	0.00		0.00
January	10,043,805	0.00		0.00
February	9,071,824	0.00		0.00
March	10,043,805	0.00		0.00
April	9,719,812	0.88	140,554	1.05
May	10,043,805	3.07	490,340	3.67
June	9,719,812	6.66	1,063,735	7.96
July	10,043,805	9.33	1,490,188	11.15
August	10,043,805	2.04	325,829	2.44
September	9,719,812	0.00	0	0.00
Totals	**118,257,710**	**21.98**	**3,510,646**	**26.26**

Forest Crop

Crop Acreage = 26

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	10,043,805	0.00		0
November	9,719,812	0.00		0
December	10,043,805	0.00		0
January	10,043,805	0.00		0
February	9,071,824	0.00		0
March	10,043,805	0.00		0
April	9,719,812	0.41	38,696	0.29
May	10,043,805	2.45	231,137	1.73
June	9,719,812	5.12	483,226	3.61
July	10,043,805	8.27	780,523	5.84
August	10,043,805	6.07	572,887	4.28
September	9,719,812	3.23	304,847	2.28
Totals	**118,257,710**	**25.55**	**2,372,619**	**18.04**

New Forest Crop

Crop Acreage = 2.5

IWR

Month	Expected Monthly Flow Rate (gal/month)	Irrigation Water Requirement	Irrigated Volume Forest Crop (ft^3)	Irrigated Volume Forest Crop (MG)
October	10,043,805	0.00		0
November	9,719,812	0.00		0
December	10,043,805	0.00		0
January	10,043,805	0.00		0
February	9,071,824	0.00		0
March	10,043,805	0.00		0
April	9,719,812	0.41	3,721	0.03
May	10,043,805	2.45	22,225	0.17
June	9,719,812	5.12	46,464	0.35
July	10,043,805	8.27	75,050	0.56
August	10,043,805	6.07	55,085	0.41
September	9,719,812	3.23	29,312	0.22
Totals	**118,257,710**	**25.55**	**228,136**	**1.73**

Appendix D-1

DEQ Correspondence, 2017 Irrigation Application

James A. Sewell & Associates, LLC

From:	Marcia.Babcock@deq.idaho.gov
Sent:	Monday, October 02, 2017 1:30 PM
To:	cityclerk@spiritlakeid.gov
Cc:	Eric Eldenburg; Kevin Koesel; luke@spiritlakeid.gov; John.Tindall@deq.idaho.gov; Marcia.Babcock@deq.idaho.gov
Subject:	Emailing: WW Spirit Lake city of - M-002-05 - Proposed Irrigation Overage - 09-15-17.PDF, WW Spirit Lake, City of - M-002-05 - Approval of Irrigation in Excess of Hydraulic Loading Rates - 09-25-17.pdf
Attachments:	WW Spirit Lake city of - M-002-05 - Proposed Irrigation Overage - 09-15-17.PDF; WW Spirit Lake, City of - M-002-05 - Approval of Irrigation in Excess of Hydraulic Loading Rates - 09-25-17.pdf

Please see attached documents for your reuse records.
John, I will email the file/TRIM reference separately to DEQ staff for convenience of review. m

Your message is ready to be sent with the following file or link attachments:

WW Spirit Lake city of - M-002-05 - Proposed Irrigation Overage - 09-15-17.PDF WW Spirit Lake, City of - M-002-05 - Approval of Irrigation in Excess of Hydraulic Loading Rates - 09-25-17.pdf

Note: To protect against computer viruses, e-mail programs may prevent sending or receiving certain types of file attachments. Check your e-mail security settings to determine how attachments are handled.

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

2110 Ironwood Parkway, Coeur d'Alene, ID 83814 (208) 769-1422
C. L. "Butch" Otter, Governor
John Tippets, Director

September 25, 2017

Mayor Todd Clary
City of Spirit Lake
PO Box 309
Spirit Lake, ID 83869
cityclerk@spiritlakeid.gov

Subject: **City of Spirit Lake,** Reuse Permit M-002-05, One-Time Approval to Irrigate in Excess of Permitted Hydraulic Loading Rates

Dear Mayor Clary:

The Idaho Department of Environmental Quality (DEQ) has received the request through your consultant Kevin Koesel, P.E., to irrigate in excess of the permitted hydraulic loading rates on the city of Spirit Lake's 106.7 acre reuse site in order to adequately lower the water level in the wastewater lagoons prior to the end of permitted growing season (October 31, 2017). The level in the lagoons must be lowered to the minimum operating levels by October 31 to have sufficient capacity to store the volume of wastewater and precipitation anticipated to be generated during the non-growing season (November 1, 2017 to March 31, 2018). If the lagoons were to become full prior to the start of the growing season (April 1, 2018) when irrigation of the fields is permitted, there are few options for protecting the integrity of the lagoons without risking potential impacts to public health and the environment.

The city has a self-imposed moratorium on the issuance of new building permits until additional lagoon storage can be constructed. This demonstrates that the city understands the severity of the problem faced. Compliance with the reuse permit limits and conditions are particularly important to protect the water quality of the Rathdrum Prairie Aquifer which underlies the reuse site. The city will need to move quickly to add storage volume and avoid a repeat of these same circumstances next year. Violations of the reuse permit and/or the Ground Water Quality Rule (IDAPA 58.01.11) could result in enforcement action.

DEQ has agreed that the best option under these circumstances is a one-time approval of irrigation in September and October 2017 in excess of the permitted hydraulic loading rates. The permitted hydraulic loading rates are based on estimated mean IWRs for the field crops and the estimated 80% exceedance IWRs for the forested sites. The city is currently permitted to irrigate 106.7 acres. Reuse Permit Condition 4.2 requires the hydraulic loading rates to be "substantially at the irrigation water requirement (IWR)" for the field crops (alfalfa and grass/oats) and "substantially at or below the irrigation water requirement (IWR)" for the forested sites (Fields 4 & 5). The enclosure titled "Irrigation Overage Proposal" provides the scheduled irrigation of the fields to achieve the goal of sufficiently lowering the lagoon levels. Using this schedule, the estimated hydraulic loading rates in excess of the mean and 80% exceedance IWRs is 2.6 inches

(7.5 million gallons). This also equates to approximately 18 lbs. total nitrogen/acre that will be applied with the water (assuming 30 mg/L total nitrogen in the irrigated recycled water).

The following conditions will apply to DEQ's one-time approval of irrigation in excess of the permitted hydraulic loading rates:

1. All other conditions in the Reuse Permit M-002-05, Permit Modification 1 and the July 13, 2017 DEQ approval to temporarily irrigate 22 acres in Field 1 will continue to apply;
2. Irrigate approximately in accordance with the enclosure "Irrigation Overage Proposal";
3. Obtain quarterly samples from the Spirit Lake Industrial Park public water system (PWS #ID1090212) public drinking water well and the private well (Ferguson Well) located about 660 feet west of Field 5. The samples should be analyzed for the following: total nitrogen concentration; nitrogen as nitrate concentration; chloride concentration; and total coliform counts;
4. Continue using the Spirit Lake AgriMet weather data and irrigation scheduling software to show the estimated crop water demands until October 31 to compare with the actual amounts of water irrigated;
5. Obtain weekly, instead of monthly, grab samples of the irrigated recycled water and submit for analysis of total nitrogen concentration, nitrogen as nitrate concentration and chloride concentration. Continue to monitor weekly for total coliform counts;
6. All sampling, analysis and reporting should be included in a Quality Assurance Project Plan (QAPP) completed prior to sampling;
7. After the excess recycled water has been irrigated, compile all the monitoring information into a report, with the exception of the quarterly well sampling. The report should include a narrative of events, all monitoring data in table format and all the analytical laboratory reports. The October soil analytical data should be compared to previous years and any concentrations or pH that are anomalous should be noted. The report shall be completed and submitted to DEQ within 60 days after the final analytical data has been received by the city; and,
8. Submit to DEQ the quarterly analytical results from each ground water monitoring event within 30 days after the analytical data has been received by the city.

DEQ understands that the city does not want to be in this situation in the future. Please work closely with DEQ as you go through the planning, design and construction of the important upgrades of your wastewater/reuse systems. If you have any questions, please contact me at 208-666-4629 or by at john.tindall@deq.idaho.gov.

Sincerely,

John Tindall

John Tindall
John.tindall@deq.idaho.gov

enclosure: Irrigation Overage Proposal

c: Eric Eldenburg, P.E., James A. Sewell, Newport, WA eeldenburg@jasewell.com
Kevin Koesel, P.E., James A. Sewell, Newport, WA kkoesel@jasewell.com
Luke Eastman, Spirit Lake Operator luke@spiritlakeid.gov
Chris Westerman, DEQ Coeur d’Alene chris.westerman@deq.idaho.gov
Matt Plaisted, P.E., DEQ Coeur d’Alene matthew.plaisted@deq.idaho.gov
Gary Stevens, P.G., DEQ Coeur d’Alene gary.stevens@deq.idaho.gov
Alyssa Gersdorf, DEQ Coeur d’Alene Alyssa.gersdorf@deq.idaho.gov
Larry Waters, P.E., DEQ State Office, Boise larry.waters@deq.idaho.gov
Whitney Rowley, DEQ State Office, Boise whitney.rowley@deq.idaho.gov
Adam Bussan, P.E., DEQ State Office, Boise adam.bussan@deq.idaho.gov
File: TRIM WW Spirit Lake, city of (2017AGH2202)

Irrigation Overage Proposal

			September				October			
Field	Acreage	Crop	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)
1	43	Alfalfa	4.97	2	6.97	8.14	0.7	0.6	1.3	1.52
1A	22	Grass/Oats	2.75	2	4.75	2.84	0.5	0.6	1.1	0.66
2	13	Alfalfa	4.97	2	6.97	2.46	0.7	0.6	1.3	0.46
3	2.7	Grass/Trees	2	2	4	0.29	0	0.6	0.6	0.04
4	11	Forest	3.23	2	5.23	1.56	0	0.6	0.6	0.18
5	15	Forest	3.23	2	5.23	2.13	0	0.6	0.6	0.24
Total	106.7					17.42				3.10

	September - October	
Total Applied	20.52	MG

From: John.Tindall@deq.idaho.gov
Sent: Monday, October 02, 2017 11:04 AM
To: luke@spiritlakeid.gov; Kevin Koesel; cityclerk@spiritlakeid.gov
Cc: Chris.Westerman@deq.idaho.gov; Matthew.Plaisted@deq.idaho.gov
Subject: Oral Confirmation of Total Coliform Count of 79 CFUs/100 ml.

Hi Luke
Thanks for providing verbal confirmation of the total coliform count of 79 CFUs/100 ml. from your last sample. You said you were withdrawing recycled water from Lagoon #2 and were down to a level where there were higher concentrations of solids which may have created a higher chlorine demand. As you are aware, the 7/13/17 DEQ letter to Mayor Clary regarding the temporary approval for irrigating the additional 22 acres of Field 1 included the following Condition #2:

"The disinfection limit for irrigation of this acreage will be changed to no sample shall exceed 23 total coliform organisms/100 mL from the weekly samples taken from the sample port, post-disinfection. If there is an exceedance of this limit, irrigation of the 22 acres in Field 1 will cease until it can be demonstrated that the disinfection limit is achieved."

Please follow this procedure and provide a written (email is fine) notification of the exceedance within 5 days. Thanks. JT

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Chris Westerman
Sent: Monday, October 02, 2017 10:33 AM
To: John Tindall
Subject: FW: Voice message: from "Unknown" (+1 (208) 6606167)

Thanks for looking into this and speaking with Luke.

Chris

From: Chris Westerman
Sent: Monday, October 02, 2017 10:33 AM
To: John Tindall
Subject: FW: Voice message: from "Unknown" (+1 (208) 6606167)

Hi John,

Here's Luke's voicemail about the TC hit.

Chris

From: Unified Messaging
Sent: Monday, October 02, 2017 9:30 AM
To: Chris Westerman
Subject: Voice message: from "Unknown" (+1 (208) 6606167)

Kevin Koesel

From: John.Tindall@deq.idaho.gov
Sent: Monday, October 02, 2017 10:31 AM
To: Kevin Koesel; Chris.Westerman@deq.idaho.gov
Cc: luke@spiritlakeid.gov; Matthew.Plaisted@deq.idaho.gov
Subject: RE: Spirit Lake Proposed Irrigation Overage

Hi Kevin
I just got back in the office. I had the letter ready to go last Monday but it didn't get sent out. We'll try again today. I'll call Luke. Thanks. JT

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Monday, October 02, 2017 9:47 AM
To: John Tindall; Chris Westerman
Cc: Luke Eastman
Subject: RE: Spirit Lake Proposed Irrigation Overage

John & Chris,

You were going to provide a letter to the City regarding our proposed irrigation overage. Can you let me know the status of that so I can notify the City?

Thanks,

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

From: John.Tindall@deq.idaho.gov [mailto:John.Tindall@deq.idaho.gov]
Sent: Friday, September 15, 2017 10:48 AM
To: Kevin Koesel
Subject: RE: Spirit Lake Proposed Irrigation Overage

Thanks Kevin.

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Friday, September 15, 2017 10:42 AM
To: John Tindall; Chris Westerman
Cc: 'Ann Clapper'; Eric Eldenburg; Luke Eastman
Subject: Spirit Lake Proposed Irrigation Overage

John,

As we discussed on the phone this morning, I have revised my proposed irrigation overage worksheet to identify 2" of additional irrigation throughout the site in September and have reduced the October overage to 0.6". This will equate to irrigating a total of 2.6" beyond the predicted IWR in order to empty the storage lagoon cells prior to winter. Luke would continue to record and note irrigation events in the Irrigation Scheduler, however; there will be days when the scheduler does not register a precipitation deficit and we will continue to irrigate. I understand that there will be some additional monitoring of the nearby private and public wells to facilitate this plan. I also understand that DEQ views this as a one-time solution and is not something that will commonly be allowed in the future.

Thank you for your help on this matter.

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

From:	John.Tindall@deq.idaho.gov
Sent:	Friday, September 15, 2017 10:48 AM
To:	Kevin Koesel
Subject:	RE: Spirit Lake Proposed Irrigation Overage

Thanks Kevin.

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Friday, September 15, 2017 10:42 AM
To: John Tindall; Chris Westerman
Cc: 'Ann Clapper'; Eric Eldenburg; Luke Eastman
Subject: Spirit Lake Proposed Irrigation Overage

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As we discussed on the phone this morning, I have revised my proposed irrigation overage worksheet to identify 2” of additional irrigation throughout the site in September and have reduced the October overage to 0.6”. This will equate to irrigating a total of 2.6” beyond the predicted IWR in order to empty the storage lagoon cells prior to winter. Luke would continue to record and note irrigation events in the Irrigation Scheduler, however; there will be days when the scheduler does not register a precipitation deficit and we will continue to irrigate.   I understand that there will be some additional monitoring of the nearby private and public wells to facilitate this plan. I also understand that DEQ views this as a one-time solution and is not something that will commonly be allowed in the future.

Thank you for your help on this matter.

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Irrigation Overage Proposal

			September				October			
Field	Acreage	Crop	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)
1	43	Alfalfa	4.97	2	6.97	8.14	0.7	0.6	1.3	1.52
1A	22	Grass/Oats	2.75	2	4.75	2.84	0.5	0.6	1.1	0.66
2	13	Alfalfa	4.97	2	6.97	2.46	0.7	0.6	1.3	0.46
3	2.7	Grass/Trees	2	2	4	0.29	0	0.6	0.6	0.04
4	11	Forest	3.23	2	5.23	1.56	0	0.6	0.6	0.18
5	15	Forest	3.23	2	5.23	2.13	0	0.6	0.6	0.24
Total	106.7					17.42				3.10

	September - October	
Total Applied	20.52	MG

Kevin Koesel

From: Kevin Koesel
Sent: Wednesday, September 13, 2017 1:45 PM
To: John.Tindall@deq.idaho.gov; Chris.Westerman@deq.idaho.gov
Cc: 'Ann Clapper'; Eric Eldenburg; Luke Eastman; Kevin Koesel
Subject: Spirit Lake Proposed Irrigation Sept - Oct
Attachments: Proposed Irrigation Overage SL 9-13-17.pdf

John,

I have attached a worksheet showing how we propose to irrigate 20.6 million gallons over September and October in order to leave the lagoon cells empty prior to the storage season. I calculated that we need to apply an additional 2.6" over the entire site. I have spread this amount out equally amongst each field with ½ being applied in September and ½ being applied in October. Luke has continued to irrigate up to the limits set by the Agrimet Station to date. We spoke about experimenting with his pumping rate and disinfection to try and pump additional water. Please let me know if there is anything in addition that you need from me and let me know how to proceed.

Thank you,

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Irrigation Overage Proposal

			September				October			
Field	Acreage	Crop	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)	Calculated IWR (in)	Proposed Overage (in)	Total Applied (in)	Equivalent Volume (MG)
1	43	Alfalfa	4.97	1.3	6.27	7.32	0.7	1.3	2	2.34
1A	22	Grass/Oats	2.75	1.3	4.05	2.42	0.5	1.3	1.8	1.08
2	13	Alfalfa	4.97	1.3	6.27	2.21	0.7	1.3	2	0.71
3	2.7	Grass/Trees	2	1.3	3.3	0.24	0	1.3	1.3	0.10
4	11	Forest	3.23	1.3	4.53	1.35	0	1.5	1.5	0.45
5	15	Forest	3.23	1.3	4.53	1.85	0	1.5	1.5	0.61
Total	106.7					15.39				5.27

	September - October
Total Applied	20.66

From:	Kevin Koesel
Sent:	Friday, September 01, 2017 12:43 PM
To:	John.Tindall@deq.idaho.gov; Chris.Westerman@deq.idaho.gov
Cc:	Luke Eastman; 'Ann Clapper'; Eric Eldenburg; Kevin Koesel
Subject:	Spirit Lake Lagoon Inventory
Attachments:	IWR vs Agrimet 2017 9-1-17.pdf; Lagoon Volume Accounting 2017 - August.pdf; nitrogen loading 9-1-17.pdf

John and Chris,

I have attached three worksheets where Luke and I have been tracking lagoon volume, irrigation volume, nitrogen loading, and the Agrimet station versus the calculated IWR application. As of the end of August we have lagoon cell No. 4 nearly empty. I estimate that we still have 21 MG left to irrigate. Last month we were able to irrigate a little over 11 MG. It does not appear that we will be completely empty by October 1st. Luke has been irrigating up to the Agrimet limits set each day by the irrigation scheduler. With the end of the growing season coming, the allowable irrigation amounts will be dropping. I estimate that we will need to irrigate beyond those limits if we are to dispose of all the water in the lagoon cells prior to the storage season. If that is the case, I believe the best option would be to irrigate heavier during the beginning of September rather than in October. The weather is predicted to be hot and dry for the next week or so.

The nitrogen loading is in excess of the limit for field 4 and will likely be over for field 5 once we are completed for the season. I believe our high nitrogen concentrations are a reflection of an inadequate treatment process. We installed aerators in cell No. 3 and the City has plans for the same addition in cell No. 4.

Please let us know how you would prefer we proceed on these issues.

Thanks,

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
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600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Date: 8/31/2017
By: KAK

Dike Elevation 2370.6

Date	Lagoon #1		Lagoon #2		Lagoon #3		Lagoon #4		Total Volume in storage (mg)	Irrigated To Date (mg)
	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)		
4/30/2017									51.7	
5/31/2017		0.57							46	4.03
6/30/2017		0.57	2367.25	7.23	2364.69	4.9	2367.75	30.67	**43.37**	11.41
7/31/2017		0.57	2368.78	10.47	2358.7	2.6	2357.5	12.85	**26.49**	30.14
8/31/2017		0.57	2368.78	10.47	2363.19	5.2	2347.5	0.5	**16.74**	42.88
9/30/2017		0.57								

Estimated Irrigation Volume, Estimated IWR, (MG)

Month	Influent	Field 1 (43 acres)	Field 1A (22 acres) Temp. Permit	Field 2 (13 acres)	Field 3 (2.7 acres)	Field 4 (11 acres)	Field 5 (15 acres)	
April	4.55	2.2		0.67		0.12		
May	4.36	6		1.8		0.74		
June	4.24	5.5		1.65		1.53		
July	4.39	9.7	5.57	2.93	0.48	2.47	3.37	
August	4.25	6.2	1.22	1.88	0.34	1.81	2.47	
September	4.26	5.8		1.75	0.2	0.96	1.31	10.02
October	4.26	0.8		0.25	0	0	0	1.05
	17.16							**11.07**

Lagoon	**Dead Storage**	**Base Elev.**
1	0.57	2358.6
2	1.3	2356.42
3	0.7	2352.69
4	2.0	2347
Total	**4.57**	

9/1/2017 10/1/2017 30

What if we added 22 acres of spring grain in field 1

	(in)	M.G.
July	9.33	5.57
August	2.04	1.22
September	0	0
October	0	0
Total	11.37	**6.79**

Summary

To Irrigate

Current +	Influent -	Dead Storage =	Total
16.74	8.52	4.57	**20.69**

Permitted Irrigation = **11.07**

Difference **-9.62**

Overflow Pipes

	From Cell	To Cell	Pipe
	1	2	8"
I.E.	2368.33	2368.92	
	2	3	8"
I.E.	2368.78	2368.76	
	3	4	8"
I.E.	2368.89	2368.86	

Field			1	1a	2	3	4	5
Crop			Alfalfa	Oats	Alfalfa	Grass/Seedling Trees	Forest Crop	Forest Crop
Acreage			43	22	13	2.7	11	15
Month	Influent	Average GPD	N applied (lbs/acre)	N applied (lbs/acre)	N applied (lbs/acre)	N applied (lbs/acre)	N applied (lbs/acre)	N applied (lbs/acre)
April	4,546,489	151,550						
May	4,357,164	140,554	28.03		29.64			
June	4,237,499	141,250	37.23		28.01		66.84	
July	4,385,587	141,471	50.84	23.75	64.81	32.28	66.03	78.85
August	4,251,439	137,143	30.81	12.97	23.87	2.18	42.69	38.87
September								
October								
Total			146.91	36.72	146.33	34.46	175.56	117.72
Permit Limit						155	140	140

Field	1		1a		2		3		4		5	
Crop	Alfalfa		Oats		Alfalfa		Grass/Seedling Trees		Forest Crop		Forest Crop	
Acreage	43		22		13		2.7		11		15	
Month	Calculated IWR, DEQ Staff Analysis (in)	Agrimet, WSU Irrigation Scheduler, (in)	Calculated IWR, DEQ Staff Analysis (in)	Agrimet, WSU Irrigation Scheduler, (in)	Calculated IWR, DEQ Staff Analysis (in)	Agrimet, WSU Irrigation Scheduler, (in)	Calculated IWR, DEQ Staff Analysis, 80%	Agrimet, WSU Irrigation Scheduler	Calculated IWR, DEQ Staff Analysis, 80%	Agrimet, WSU Irrigation Scheduler	Calculated IWR, DEQ Staff Analysis, 80%	Agrimet, WSU Irrigation Scheduler
April	1.89		0.88		1.89		0.22		0.41		0.41	
May	5.11	2.65	3.07		5.11	2.66	1.95		2.49		2.49	
June	4.68	3.75	6.66		4.68	2.80	2.61		5.12	6.77	5.12	
July	8.31	6.45	9.33	3.07	8.31	8.34	4.91	4.50	8.27	6.90	8.27	9.90
August	5.34	4.88	2.04	2.01	5.34	3.68	3.49	0.34	6.07	6.70	6.07	6.14
September	4.97		0.00		4.97		2.00		3.23		3.23	
October	0.70		0.00		0.70		0.00		0.00		0.00	
Total (in)	31.00	17.73	21.98	5.08	31.00	17.48	15.18	4.84	25.59	20.37	25.59	16.04
Total (MG)	36.19	20.70	13.13	3.03	10.94	6.17	1.11	0.35	7.64	6.08	10.42	6.53

MG Applied	79.44	DEQ Staff Analysis
MG Applied	42.88	Agrimet

Kevin Koesel

From:	Chris.Westerman@deq.idaho.gov
Sent:	Wednesday, August 09, 2017 9:15 AM
To:	Kevin Koesel; luke@spiritlakeid.gov
Cc:	John.Tindall@deq.idaho.gov; cityclerk@spiritlakeid.gov; mayor@spiritlakeid.gov; Eric Eldenburg
Subject:	RE: Spirit Lake Irrigation

Hi Luke,

I added Field 1A-MU-002-01A (Grass pasture) to your irrigation scheduler. You should be good to go once the oats are established. Let me know if there are any issues. Thanks.

Chris

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Tuesday, August 08, 2017 2:58 PM
To: Luke Eastman
Cc: John Tindall; Chris Westerman; 'Ann Clapper'; Todd Clary; Eric Eldenburg; Kevin Koesel
Subject: Spirit Lake Irrigation

Luke,

I wanted to follow up with you regarding a phone conversation that John and I had concerning your Field 1A at the WWTP. This is the new portion of field #1 under Pivot No. 1 that we seeded oats into this spring and began irrigating under a temporary permit issued by DEQ on July 13, 2017. As you are aware, the oat crop has reached the end of its normal growth cycle. The oat plants have stopped growing, formed seed heads, began to dry out and turned from green to yellow. This is normal for an oat crop seeded in the spring and harvested in August. Our irrigation scheduling program recognizes that the plant are not actively growing and consequently will not allow any additional irrigation on this field. In order to continue irrigation on this field John and I have discussed the following option:

1. Reseed an oat crop in this field as soon as possible,
2. Provide irrigation to the oat crop during the initial emergent stage (first two weeks) based on soil moisture in the top 6 inches (initial root zone) of the profile. This would include:
   a. Wetting the soil following seeding to promote germinate and growth of the new plants,
   b. Monitoring and noting the soil moisture in the top 6" of the profile visually,
   c. Applying irrigation based on soil moisture in the top 6" of the profile. The goal is to not let the soil become excessively dry. More frequent application of low volumes of irrigation (less than 0.5" per application) would be best.
   d. Irrigation events would be noted along with observed soil moisture conditions.
3. ~~Following the plant emergent stage, DEQ would assist in setting up a new field in the irrigation scheduler program based on a grass crop. In this way you would be able to set irrigation rates for this field similar to how you are managing the remainder of the WWTP fields.~~
   I added Field 1A-MU-002-01A (Grass pasture) to your irrigation scheduler.

The goal of this oat crop is twofold. First, we are providing a crop to irrigate on this field to provide area for wastewater application. Second, the oats will be plowed or disked into the ground to try and build up the soil organic matter. This field appears lacking in soil organic matter and the addition of green vegetation to the soil profile will help develop and sustain your future alfalfa crop.

Thanks and contact me with any questions or concerns.

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
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Kevin Koesel

From: Kevin Koesel
Sent: Tuesday, August 08, 2017 2:58 PM
To: Luke Eastman
Cc: John.Tindall@deq.idaho.gov; Chris.Westerman@deq.idaho.gov; 'Ann Clapper'; Todd Clary; Eric Eldenburg; Kevin Koesel
Subject: Spirit Lake Irrigation

Luke,

I wanted to follow up with you regarding a phone conversation that John and I had concerning your Field 1A at the WWTP. This is the new portion of field #1 under Pivot No. 1 that we seeded oats into this spring and began irrigating under a temporary permit issued by DEQ on July 13, 2017. As you are aware, the oat crop has reached the end of its normal growth cycle. The oat plants have stopped growing, formed seed heads, began to dry out and turned from green to yellow. This is normal for an oat crop seeded in the spring and harvested in August. Our irrigation scheduling program recognizes that the plant are not actively growing and consequently will not allow any additional irrigation on this field. In order to continue irrigation on this field John and I have discussed the following option:

1. Reseed an oat crop in this field as soon as possible,
2. Provide irrigation to the oat crop during the initial emergent stage (first two weeks) based on soil moisture in the top 6 inches (initial root zone) of the profile. This would include:
    a. Wetting the soil following seeding to promote germinate and growth of the new plants,
    b. Monitoring and noting the soil moisture in the top 6" of the profile visually,
    c. Applying irrigation based on soil moisture in the top 6" of the profile. The goal is to not let the soil become excessively dry. More frequent application of low volumes of irrigation (less than 0.5" per application) would be best.
    d. Irrigation events would be noted along with observed soil moisture conditions.
3. Following the plant emergent stage, DEQ would assist in setting up a new field in the irrigation scheduler program based on a grass crop. In this way you would be able to set irrigation rates for this field similar to how you are managing the remainder of the WWTP fields.

The goal of this oat crop is twofold. First, we are providing a crop to irrigate on this field to provide area for wastewater application. Second, the oats will be plowed or disked into the ground to try and build up the soil organic matter. This field appears lacking in soil organic matter and the addition of green vegetation to the soil profile will help develop and sustain your future alfalfa crop.

Thanks and contact me with any questions or concerns.

Kevin A. Koesel, P.E.
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600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Kevin Koesel

From: John.Tindall@deq.idaho.gov
Sent: Friday, August 04, 2017 1:15 PM
To: Kevin Koesel
Cc: Chris.Westerman@deq.idaho.gov; luke@spiritlakeid.gov
Subject: FW: Spirit Lake Lagoon Water Balance - July Update
Attachments: Lagoon Volume Accounting 2017 - July.pdf

Thanks Kevin. Some more good evaporation in August and September could help with that 5.47 MG difference. The AgriMet Station should be giving us crop water usage data that is higher than the average estimated IWR. JT

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Wednesday, August 02, 2017 11:36 AM
To: John Tindall
Cc: Luke Eastman
Subject: Spirit Lake Lagoon Water Balance - July Update

John,

I have attached our monthly lagoon water balance accounting for Spirit Lake WWTP. As you can see we believe we are going to be tight.

Thanks,

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Dike Elevation 2370.6

Date: 7/31/2017
By: KAK

Date	Lagoon #1		Lagoon #2		Lagoon #3		Lagoon #4		Total Volume in storage (mg)	Irrigated To Date (mg)
	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)		
5/31/2017		0.57							46	
6/30/2017		0.57	2367.25	7.23	2364.69	4.9	2367.75	30.67	**43.37**	11
7/31/2017		0.57	2368.78	10.47	2358.7	2.6	2357.5	12.85	**26.49**	36
8/31/2017		0.57								
9/30/2017		0.57								

Estimated Irrigation Volume, Estimated IWR, (MG)

Month	Influent	Field 1 (43 acres)	Field 1A (22 acres) Temp. Permit	Field 2 (13 acres)	Field 3 (2.7 acres)	Field 4 (11 acres)	Field 5 (15 acres)	
April		2.2		0.67		0.12		
May		6		1.8		0.74		
June		5.5		1.65		1.53		
July		9.7	5.57	2.93	0.48	2.47	3.37	
August	4.34	6.2	1.22	1.88	0.34	1.81	2.47	13.92
September	4.2	5.8		1.75	0.2	0.96	1.31	10.02
October		0.8		0.25	0	0	0	1.05
	8.54							**24.99**

Lagoon	**Dead Storage**	**Base Elev.**
1	0.57	2358.6
2	1.3	2356.42
3	0.7	2352.69
4	2.0	2347
Total	**4.57**	

8/1/2017 10/1/2017 61

What if we added 22 acres of spring grain in field 1

	(in)	M.G.
July	9.33	5.57
August	2.04	1.22
September	0	0
October	0	0
Total	11.37	**6.79**

Summary

To Irrigate			
Current +	Influent -	Dead Storage =	Total
26.49	8.54	4.57	**30.46**
Permitted Irrigation =			**24.99**
Difference			**-5.47**

Overflow Pipes

	From Cell	To Cell	Pipe
	1	2	8"
I.E.	2368.33	2368.92	
	2	3	8"
I.E.	2368.78	2368.76	
	3	4	8"
I.E.	2368.89	2368.86	

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

2110 Ironwood Parkway, Coeur d'Alene, ID 83814 (208) 769-1422
C. L. "Butch" Otter, Governor
John Tippets, Director

July 13, 2017

CERTIFIED RETURN RECEIPT: 7011 0110 0000 4529 7244

Mayor Todd Clary
City of Spirit Lake
P.O. Box 309
Spirit Lake, ID 83869
cityclerk@spiritlakeid.gov

Subject: **City of Spirit Lake,** Reuse Permit M-002-05, Temporary Approval to Irrigate 22 Acres of Field 1

Dear Mayor Clary:

The Idaho Department of Environmental Quality (DEQ) has received your request dated July 11, 2017 to allow the temporary irrigation of the 22 acres of oats in Field 1 (MU-002-01) currently not permitted in Reuse Permit M-002-05. You are also requesting that DEQ issue a permit modification for irrigation of this acreage at some later date. This request is being made to provide additional acreage for irrigation and allow the city to lower the volume of water in the lagoons by October 31, 2017 (end of the permitted growing season) to a level sufficient to provide adequate storage volume for the wastewater and precipitation received during the next non-growing season (November 1, 2017 to March 31, 2018). The inventory of wastewater in the lagoons was higher in 2017 due to greater than normal amounts of precipitation during the 2016-2017 winter season and growth in the city.

DEQ has not permitted irrigation of this acreage to-date because there is a water main owned by the Spirit Lake Industrial Park water system (#ID1090212) which runs through this acreage. The water main has been in Field 1 since the City started irrigating recycled water in the 1980s, but it was not until DEQ started to work with the City on Permit Modification 1 that the location of the water main was identified. Due to the severity of the city's lagoon storage problem, the city has requested that DEQ allow temporary irrigation of the acreage with the water main in its current location. DEQ understands that the City is committed to relocating the water main. Your request for a permit modification will not be processed until you have demonstrated to DEQ that you have a clear path forward for getting the water main relocated.

Reuse Permit M-002-05 identifies you as the responsible facility official. By means of this letter, DEQ authorizes you to temporarily irrigate this acreage until no later than October 31, 2017 prior to receiving a permit modification from DEQ for this irrigation. The following conditions apply as part of this authorization:

1. All conditions and requirements of Reuse Permit M-002-05 and Permit Modification 1 will apply to the irrigation of this acreage, with the exception of the disinfection limits (see Section 4.5 of the final permit) and the 25 foot buffer distance from a public water system main line (see Item 5 of Permit Modification 1 dated June 30, 2017) as discussed in Items 2 and 3 below;
2. The disinfection limit for irrigation of this acreage will be changed to no sample shall exceed 23 total coliform organisms/100 mL from the weekly samples taken from the sample port, post-disinfection. If there is an exceedance of this limit, irrigation of the 22 acres in Field 1 will cease until it can be demonstrated that the disinfection limit is achieved;
3. The 25 foot buffer distance requirement from public water system main lines will not apply to irrigation within these 22 acres of Field 1. The center pivot will travel over the water main and irrigation can occur as the pivot passes over the water main;
4. Any depressurization events for the Spirit Lake Industrial Park Water System (#ID1090212) between July 12, 2017 and October 31, 2017 will require that the City cease irrigation over the water main in the 22 acres of Field 1 until the water system has demonstrated to DEQ that the problem has been resolved;
5. Aerosol drift from irrigation of this acreage must be prevented. In addition, if the hourly average wind speed exceeds 10 miles per hour (mph) from wind directions of 75 to105 degrees or from wind directions of 210 to 240 degrees, based on weather data from the Spirit Lake AgriMet Station (SPLI), irrigation of the 22 acres in Field 1 must cease until the conditions change;
6. Irrigation of this acreage can only occur during daylight hours when City operational staff are present;
7. The City must collect weekly total coliform samples from the Spirit Lake Industrial Park (#ID1090212) distribution system when irrigating this acreage. A sampling location should be selected and at least one (1) sample taken from this location prior to starting irrigation of this acreage. Any detection of total coliform will require irrigation of the 22 acres in Field 1 to cease until it can be shown that total coliform are is not present;
8. The City must collect monthly caffeine samples from the Spirit Lake Industrial Park (#ID1090212) distribution system when irrigating this acreage. A sampling location should be selected and at least one (1) sample taken from this location prior to starting irrigation of this acreage. Any detection of caffeine will require irrigation of the 22 acres in Field 1 to cease until it can be shown that caffeine is not present; and
9. The City must collect soil samples from this acreage in accordance with the permit requirements prior to starting irrigation and in October at the end of the irrigation season.

Please call John Tindall at 208-666-4629 or email him at john.tindall@deq.idaho.gov if you have any questions.

Sincerely,

Daniel Redline

Regional Administrator
Daniel.Redline@deq.idaho.gov

c: Eric Eldenburg, P.E., James A. Sewell, Newport, WA eeldenburg@jasewell.com
Kevin Koesel, P.E., James A. Sewell, Newport, WA kkoesel@jasewell.com
Craig Borrenpohl, P.E., DEQ Coeur d'Alene craig.borrenpohl@deq.idaho.gov
Chris Westerman, DEQ Coeur d'Alene chris.westerman@deq.idaho.gov
Matt Plaisted, P.E., DEQ Coeur d'Alene matthew.plaisted@deq.idaho.gov
Larry Waters, P.E., DEQ State Office, Boise larry.waters@deq.idaho.gov
Janelle Larson, DEQ State Office, Boise janelle.larson@deq.idaho.gov
Adam Bussan, P.E., DEQ State Office, Boise adam.bussan@deq.idaho.gov
John Tindall, DEQ Coeur d'Alene John.tindall@deq.idaho.gov
File: TRIM WW Spirit Lake, city of (2017AGH1475)

From:	Ann Clapper <cityclerk@spiritlakeid.gov>
Sent:	Tuesday, July 11, 2017 5:08 PM
To:	John.Tindall@deq.idaho.gov
Cc:	Kevin Koesel; Eric Eldenburg; luke@spiritlakeid.gov; Chris.Westerman@deq.idaho.gov; mayor@spiritlakeid.gov
Subject:	RE: Spirit Lake Water Balance Accounting
Attachments:	2017-7-11DEQ2.pdf

Update letter, signed and attached. Please let me know if it is adequate.

Thank you for your help!

Ann Clapper
Clerk/Treasurer
City of Spirit Lake
208-623-2131

From: John.Tindall@deq.idaho.gov [mailto:John.Tindall@deq.idaho.gov]
Sent: Tuesday, July 11, 2017 12:04 PM
To: cityclerk@spiritlakeid.gov
Cc: kkoesel@jasewell.com; eeldenburg@jasewell.com; luke@spiritlakeid.gov; Chris.Westerman@deq.idaho.gov; mayor@spiritlakeid.gov
Subject: RE: Spirit Lake Water Balance Accounting

Hi Ann
Thanks for getting the letter done so quickly. I was hoping to get something else added to a letter from the mayor.

First, ask DEQ to proceed with a permit modification for the additional 22 acres of Field 1 that are currently not permitted. You are correct that the application submitted by the city for the permit modification did include the 22 acres but DEQ removed this acreage from the Final Permit Modification 1.

And second, tell us what is being done to relocate the Spirit Lake Industrial Park water line from Field 1. If that is file a lawsuit if you cannot reach an agreement with the water system owners by 7/12/17 then state that as the most recent action the city is taking to remedy this situation. Thanks for your help on this. JT

John Tindall
Coeur d'Alene Regional DEQ Office
2110 Ironwood Pky.
Coeur d'Alene, ID 83814
Phone: (208) 769-1422 Ext. (4629)
Direct Line: (208) 666-4629
FAX: (208) 769-1404
Email: john.tindall@deq.idaho.gov

From: Ann Clapper [mailto:cityclerk@spiritlakeid.gov]
Sent: Tuesday, July 11, 2017 10:59 AM
To: John Tindall

Cc: 'Kevin Koesel'; 'Eric Eldenburg'; 'Luke Eastman'; Chris Westerman; mayor@spiritlakeid.gov
Subject: RE: Spirit Lake Water Balance Accounting

Good Morning John,

Please see the attached from Mayor Clary.

Thank you,

Ann Clapper

Clerk/Treasurer
City of Spirit Lake
208-623-2131

From: Kevin Koesel [mailto:kkoesel@jasewell.com]
Sent: Monday, July 10, 2017 3:36 PM
To: John.Tindall@deq.idaho.gov
Cc: 'Ann Clapper'; Eric Eldenburg; Luke Eastman; Chris.Westerman@deq.idaho.gov; Kevin Koesel
Subject: Spirit Lake Water Balance Accounting

John,

I have attached a spreadsheet summarizing the lagoon water balance accounting that we discussed this past Friday for the City of Spirit Lake wastewater treatment system. This spreadsheet shows that we expect 12.88 million gallons (MG) of influent to come into the plant between now and October. It also shows that we have 43.37 MG in storage and will be permitted to irrigate 42.72 MG up until the end of the season. The problem being 12.88 MG influent plus 43.37 MG in storage equals 56.25 MG of which we should irrigate 56.25 MG – 4.57 MG (dead storage) or 51.68 MG. We are permitted to irrigate approximately 42.72 MG. Under this scenario we would carry over roughly 51.68 MG – 42.72 MG or approximately 9 MG, which is a little over the total volume of lagoon cell No. 3. The fear is that this would create a storage problem for the City which would become apparent prior to the irrigation season next year.

Thanks in advance for any help you may be able to provide on this matter.

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

City of Spirit Lake

P.O. Box 309
Spirit Lake, ID
83869-0309

SPIRIT LAKE, IDA.
INCORPORATED 1908

6042 W. Maine Street
(208) 623-2131
Fax (208) 623-6463

July 11, 2017

Department of Environmental Quality
Coeur d'Alene Reginal Office
Attention: John Tindall
2110 Ironwood Pky.
Coeur d'Alene, ID 83814

RE: Wastewater Treatment Plant Irrigation

Dear Mr. Tindall,

The City of Spirit Lake is requesting The Department of Environmental Quality proceed with a permit modification for the additional 22 acres of Field 1 that are currently not permitted. Given the current amount of effluent stored in our wastewater treatment plant and the amounts coming in daily, it is crucial that we be allowed to irrigate this acreage. During the temporary period before the undocumented water line is removed, we will monitor the water quality at G. Andrew Street's residence on a weekly basis for total coliform bacteria.

The City of Spirit Lake has been working diligently with Spirit Lake Industrial Park to relocate their undocumented water line from our property. Most recently, if we cannot come to an agreement with them by tomorrow, July 12, the City will file a lawsuit.

Best Regards,

Todd Clary

Todd Clary
Mayor

aac

City of Spirit Lake

P.O. Box 309
Spirit Lake, ID
83869-0309

6042 W. Maine Street
(208) 623-2131
Fax (208) 623-6463

July 11, 2017

Department of Environmental Quality
Coeur d'Alene Reginal Office
Attention: John Tindall
2110 Ironwood Pky.
Coeur d'Alene, ID 83814

RE: Wastewater Treatment Plant

Dear Mr. Tindall

Given the current amount of effluent stored in The City of Spirit Lake's wastewater treatment plant and the amounts coming in daily, it is crucial that we be allowed to irrigate the additional 22 acres in field #1, as stated in the original re-use permit. During the temporary period before the undocumented water line is removed, we will monitor the water quality at G. Andrew Street's residence on a weekly basis for total coliform bacteria.

Best Regards,

Todd Clary

Todd Clary
Mayor

aac

From: Kevin Koesel
Sent: Monday, July 10, 2017 3:36 PM
To: John.Tindall@deq.idaho.gov
Cc: 'Ann Clapper'; Eric Eldenburg; Luke Eastman; Chris.Westerman@deq.idaho.gov; Kevin Koesel
Subject: Spirit Lake Water Balance Accounting
Attachments: Lagoon Volume Accounting 2017 - June.pdf

John,

I have attached a spreadsheet summarizing the lagoon water balance accounting that we discussed this past Friday for the City of Spirit Lake wastewater treatment system. This spreadsheet shows that we expect 12.88 million gallons (MG) of influent to come into the plant between now and October. It also shows that we have 43.37 MG in storage and will be permitted to irrigate 42.72 MG up until the end of the season. The problem being 12.88 MG influent plus 43.37 MG in storage equals 56.25 MG of which we should irrigate 56.25 MG – 4.57 MG (dead storage) or 51.68 MG. We are permitted to irrigate approximately 42.72 MG. Under this scenario we would carry over roughly 51.68 MG – 42.72 MG or approximately 9 MG, which is a little over the total volume of lagoon cell No. 3. The fear is that this would create a storage problem for the City which would become apparent prior to the irrigation season next year.

Thanks in advance for any help you may be able to provide on this matter.

Kevin A. Koesel, P.E.
James A. Sewell & Associates, LLC
ENGINEERING • SURVEYING • LAND USE PLANNING
600-4th Street West
Newport, Washington 99156
Phone: (509) 447-3626 (208) 437-2641
Fax: (509) 447-2112
www.jasewell.com

Date: 6/30/2017
Dike Elevation 2370.6
By: KAK

Date	Lagoon #1		Lagoon #2		Lagoon #3		Lagoon #4		Total Volume in storage (mg)	Irrigated To Date (mg)
	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)	Elevation (ft)	Volume (mg)		
5/31/2017		0.57							46	
6/30/2017		0.57	2367.25	7.23	2364.69	4.9	2367.75	30.67	**43.37**	10.996
7/31/2017		0.57								
8/31/2017		0.57								
9/30/2017		0.57								

Estimated Irrigation Volume, Estimated IWR, (MG)

Month	Influent	Field 1 (43 acres)	Field 2 (13 acres)	Field 3 (2.7 acres)	Field 4 (11 acres)	Field 5 (15 acres)	
April		2.2	0.67		0.12		
May		6	1.8		0.74		
June		5.5	1.65		1.53		
July	4.34	9.7	2.93	0.48	2.47	3.37	18.95
August	4.34	6.2	1.88	0.34	1.81	2.47	12.7
September	4.2	5.8	1.75	0.2	0.96	1.31	10.02
October		0.8	0.25	0	0	0	1.05
	12.88						**42.72**

Lagoon	**Dead Storage**
1	0.57
2	1.3
3	0.7
4	2.0
Total	**4.57**

7/15/2017 10/1/2017 78

What if we added 25 acres of spring grain in field 1

	(in)	M.G.
July	9.33	6.3
August	2.04	1.4
September	0	0
October	0	0
Total	11.37	**7.7**

Summary

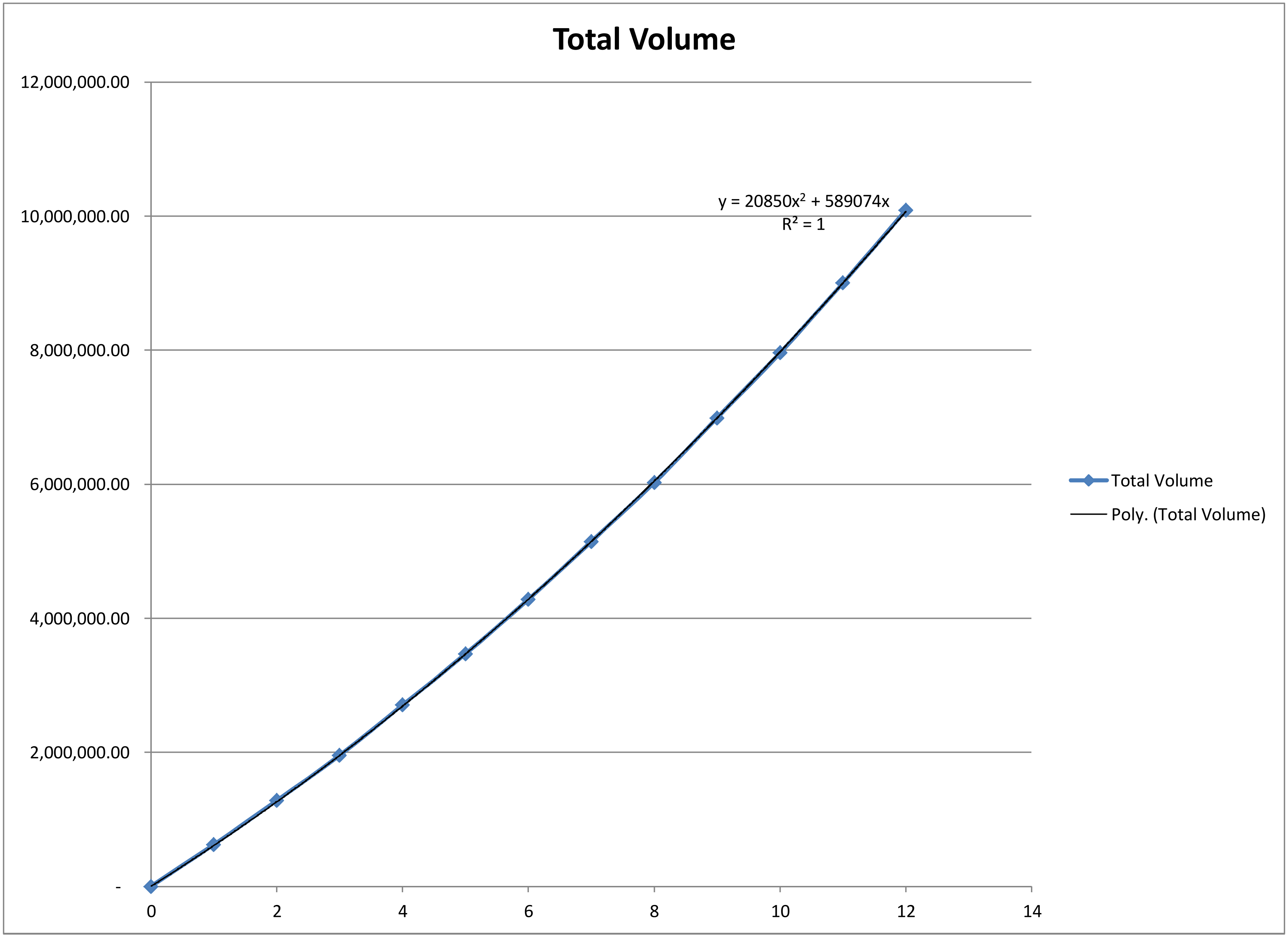
To Irrigate

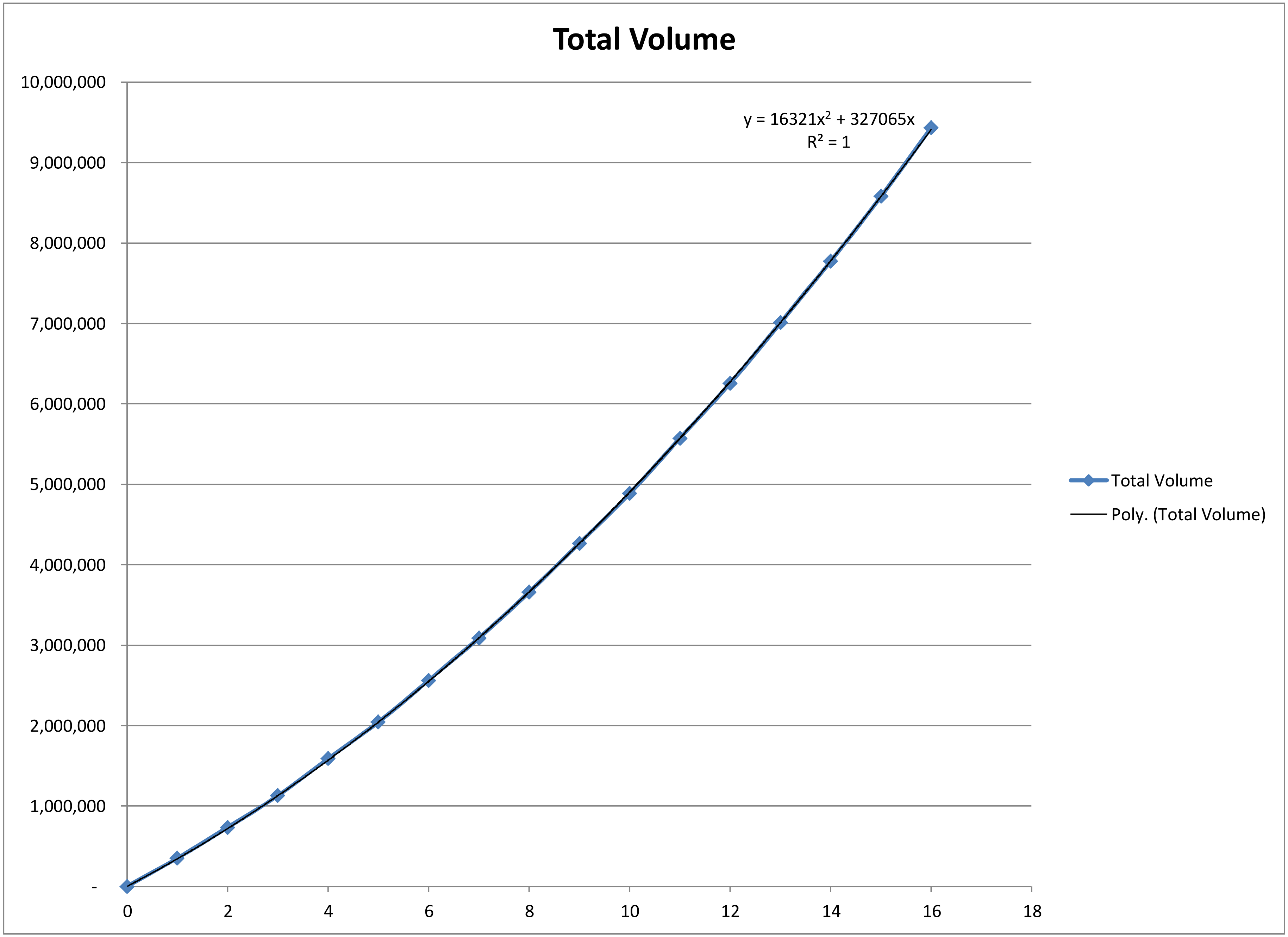
Current	+	Influent	-	Dead Storage	=	Total
43.37		12.88		4.57		**51.68**
Permitted Irrigation =						**42.72**
Difference						**-8.96**

	Cell No. 1	Cell No. 2		Cell No. 3		Cell No. 4	
Water Depth	Total Volume	Total Volume	Elevation	Total Volume	Elevation	Total Volume	Elevation
Base Elev.		2356.42		2352.69		2347.00	
0	-	-	2,356.42	-	2,352.69	-	2347.00
1		623,837	2,357.42	351,990	2,353.69	1,010,000	2348.00
2		1,282,810	2,358.42	734,852	2,354.69	2,063,000	2349.00
3		1,954,869	2,359.42	1,128,084	2,355.69	3,163,000	2350.00
4		2,705,959	2,360.42	1,590,890	2,356.69	4,307,000	2351.00
5		3,466,615	2,361.42	2,043,350	2,357.69	5,498,000	2352.00
6		4,283,560	2,362.42	2,562,752	2,358.69	6,735,000	2353.00
7		5,145,161	2,363.42	3,089,184	2,359.69	8,019,000	2354.00
8		6,023,037	2,364.42	3,658,509	2,360.69	9,350,000	2355.00
9		6,990,507	2,365.42	4,265,586	2,361.69	10,729,000	2356.00
10	xx	7,961,942	2,366.42	4,885,128	2,362.69	12,156,000	2357.00
11		9,002,653	2,367.42	5,572,556	2,363.69	13,632,000	2358.00
12		10,089,274	2,368.42	6,254,959	2,364.69	15,157,000	2359.00
13		xx	2,369.42	7,010,094	2,365.69	16,732,000	2360.00
14			2,370.42	7,771,501	2,366.69	18,356,000	2361.00
15				8,578,200	2,367.69	20,032,000	2362.00
16				9,431,463	2,368.69	21,757,000	2363.00
17					2,369.69	23,535,000	2364.00
18					2,370.69	25,363,000	2365.00
19						27,243,000	2366.00
20						29,175,000	2367.00
21						31,162,000	2368.00
22						33,200,000	2369.00
23						35,297,000	2370.00

Flooded Condition			2368.92		2368.92		2368.92
		$y = 20850x^2+589073x$		$y=16321x^2+327065x$			
12.5		10,621,225	12.50				
16.23				9,607,427	16.23		
						33,000,000	21.92
				TOTAL		**53,228,652**	

Lagoon	3			2		
Depth	Elevation	Surface Area	Volume (gal)	Elevation	Surface Area	Volume (gal)
0	2354	44,997		2358	81,058	-
0.5	2354.5	47,061		2358.5	83,407	
1	2355	49,125	351,990	2359	85,756	623,837
2	2356	53,252	734,852	2360	90,453	1,282,810
3	2357	57,150	1,128,084	2361	95,132	1,954,869
4	2358	61,048	1,590,890	2362	99,810	2,705,959
5	2359	65,046	2,043,350	2363	105,468	3,466,615
6	2360	69,043	2,562,752	2364	111,126	4,283,560
7	2361	73,356	3,089,184	2365	117,394	5,145,161
8	2362	77,668	3,658,509	2366	123,662	6,023,037
9	2363	82,186	4,265,586	2367	129,720	6,990,507
10	2364	86,704	4,885,128	2368	135,777	7,961,942
11	2365	91,840	5,572,556	2369	142,342	9,002,653
12	2366	96,975	6,254,959	2370	148,906	10,089,274
13	2367	101,931	7,010,094	2370.6	152,937	10,732,466
14	2368	106,886	7,771,501			
15	2369	112,044	8,578,200			
16	2370	117,201	9,431,463			
16.6	2370.6	121,651	9,926,694			


Total Volume
12,000,000.00
10,000,000.00
8,000,000.00
6,000,000.00
4,000,000.00
2,000,000.00
-
0
2
4
6
8
10
12
14
y = 20850x² + 589074x
R² = 1
Total Volume
Poly. (Total Volume)


Total Volume
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
0
2
4
6
8
10
12
14
16
18
y = 16321x² + 327065x
R² = 1
Total Volume
Poly. (Total Volume)

Field	1A		1		2		3		4		5	
Acres	22		43		13		2.7		11		15	
Month	MG	(in)	MG	(in)	MG	(in)	MG	(in)	MG	(in)	MG	(in)
May	0	0.00	3.2	2.74	1	2.83	0	0.00	0	0.00	0	0.00
June	0	0.00	4.5	3.85	1	2.83	0	0.00	2.02	6.76	0	0.00
July	1.8	3.01	7.7	6.60	2.9	8.22	0.3	4.09	2.5	8.37	4.1	10.07
August	1.2	2.01	5.7	4.88	1.3	3.68	0.025	0.34	2	6.70	2.5	6.14
September	2.4	4.02	6	5.14	1.8	5.10	0	0.00	1	3.35	1.4	3.44
October	1.08	1.81	1.8	1.54	0.3	0.85	0	0.00	0.4	1.34	0.89	2.19
Total	6.48	10.85	28.9	24.75	8.3	23.52	0.325	4.43	7.92	26.52	8.89	21.83

60.815 MG

Appendix D-2

Groundwater Monitoring Plan

James A. Sewell & Associates, LLC

MONKS
HYDRO-GEOSCIENCE
Hydrogeological Consulting
P.O. Box 362, Sandpoint, ID 83864

June 11, 2018

Kevin Koesel, P.E.
James A. Sewell and Associates, LLC
600-4th Street West
Newport, Washington 99156

RE: Groundwater Monitoring Plan, City of Spirit Lake Wastewater Treatment Site, Bonner County, Idaho

Dear Mr. Koesel:

Monks Hydro-Geoscience (Monks) is pleased to present this Ground Water Monitoring Plan to the City of Spirit Lake (CSL) for the CSL wastewater treatment site. CSL currently treats wastewater at a site located near the western edge of the Rathdrum Prairie Aquifer, in Section 31, T54N, R4W. The site consists of four lagoons and a 107.8-acre wastewater reuse area divided between irrigated crops and forest land. CSL is adding a fifth lagoon during the 2018 construction season, and a condition for construction of the new lagoon is to install a ground water monitoring network.

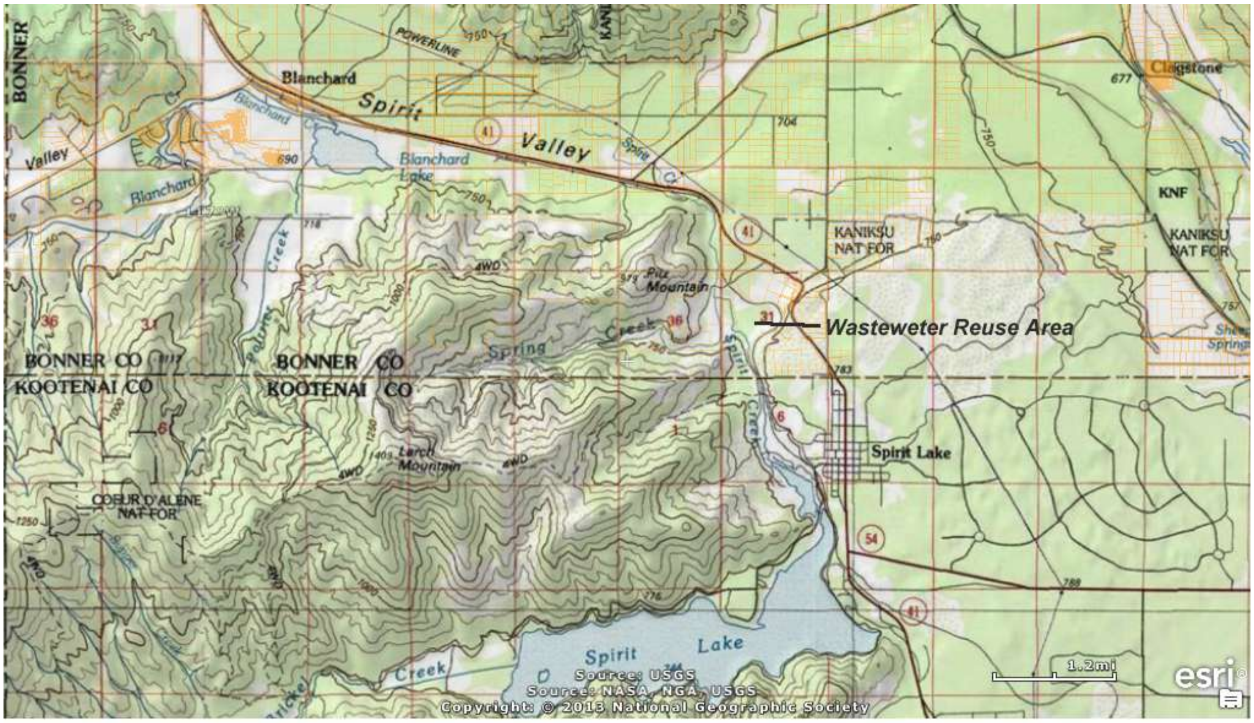


Figure 1. Project location map showing Spirit Lake, City of Spirit Lake, and City of Spirit Lake Wastewater Reuse Site.

Site Geology

The CSL wastewater reuse site is located near the northwestern edge of the Rathdrum Prairie. The site's lagoons and land application areas are located at the mouth of Spring Creek on gently rolling terrain that is partly meadow and partly forested. The lagoons are located in the southeast corner of the site, near the base of a gravel terrace. The geology of the Spirit Lake area was mapped and described by Reed et al. (2002). The Rathdrum Prairie is comprised of coarse-grained outburst flood deposited sand, gravel, cobbles, and boulders. The outburst flood deposits have been divided into three mapped units: Qgc - channel gravel; Qgsly – poorly sorted boulder flood gravel (younger); and Qgslo - poorly sorted boulder flood gravel (older.) The unconsolidated deposits of the Rathdrum Prairie are in contact with Proterozoic-aged crystalline rocks of the Priest River Metamorphic Complex that form the mountains west of the prairie.

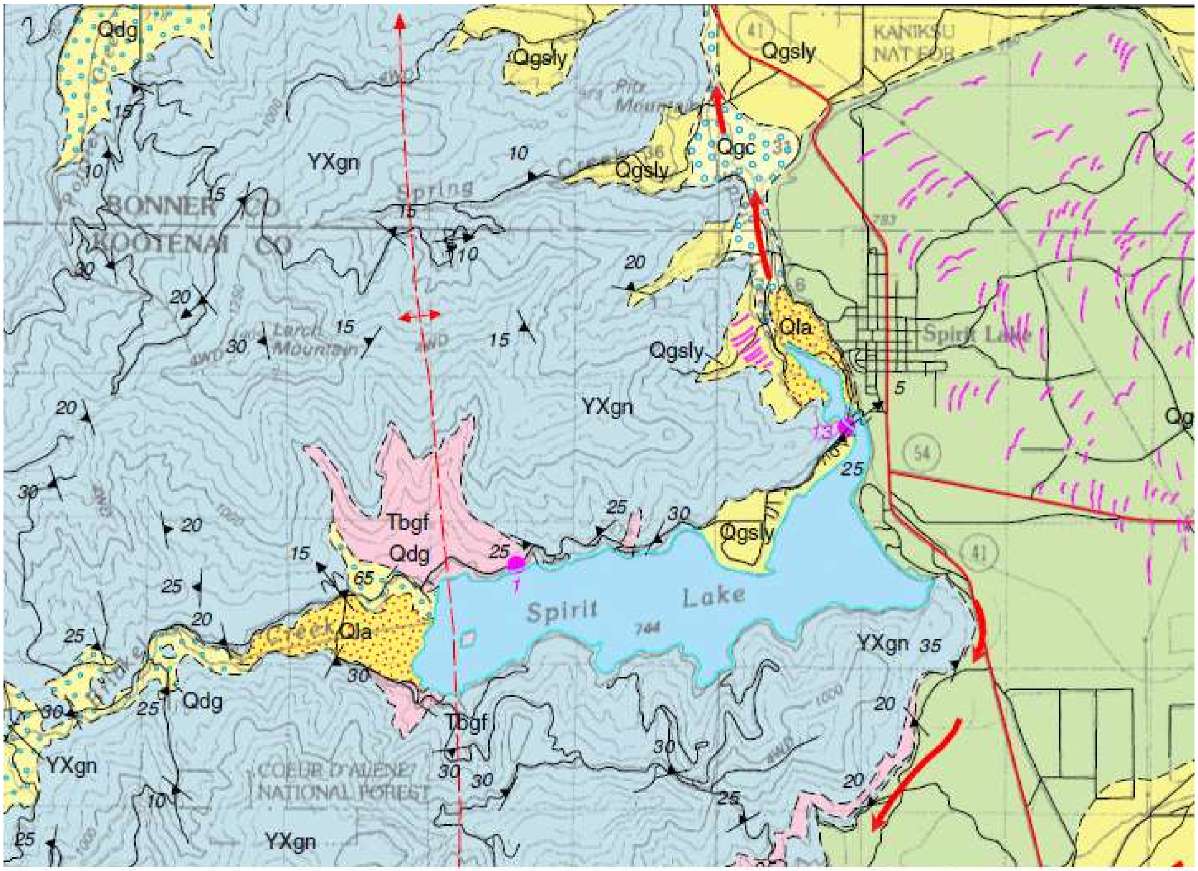


Figure 2. A portion of Geologic Map of the Coeur d'Alene 30 X 60 Minute Quadrangle, Idaho.

Site Hydrogeology

The site sits above the Rathdrum Prairie Aquifer, near the boundary between the aquifer and the crystalline metamorphic and igneous rocks. The Rathdrum Prairie Aquifer is an unconsolidated deposit aquifer that is the sole-source of drinking water for more than 500,000 people (Kahle & Bartolino, 2007). The aquifer consists mostly of gravels, cobbles, and boulders deposited during a series of outburst floods resulting from repeated collapse of the ice dam that formed Glacial Lake Missoula. The coarse-grained sands and gravels are very permeable. The hydraulic conductivity of coarse sand and gravel ranges from 9 x 10^{-7} cm/sec to 3 x 10^{-2} cm/sec

(Domenico and Schwartz, 1990). The thickest part of the aquifer (800 – 1000 feet thick) is just east of the project site.

Depth to water in the aquifer near the site ranges from 175 feet to more than 500 feet below ground surface. Water levels in the aquifer vary on seasonal basis. Well 53N 04W 08CAB1 is located just east of Spirit Lake. Depth-to-water in the well varied 14.01’ from 526.25’ to 540.26’ bct between November 2016 and May 2017. At well 53N 04W 28CAB1 the water level varied 14.81’ over a three-year period from January 2014 through August 2017. Hydrographs for wells in the vicinity of Spirit Lake with water level data are shown in Figure 3.

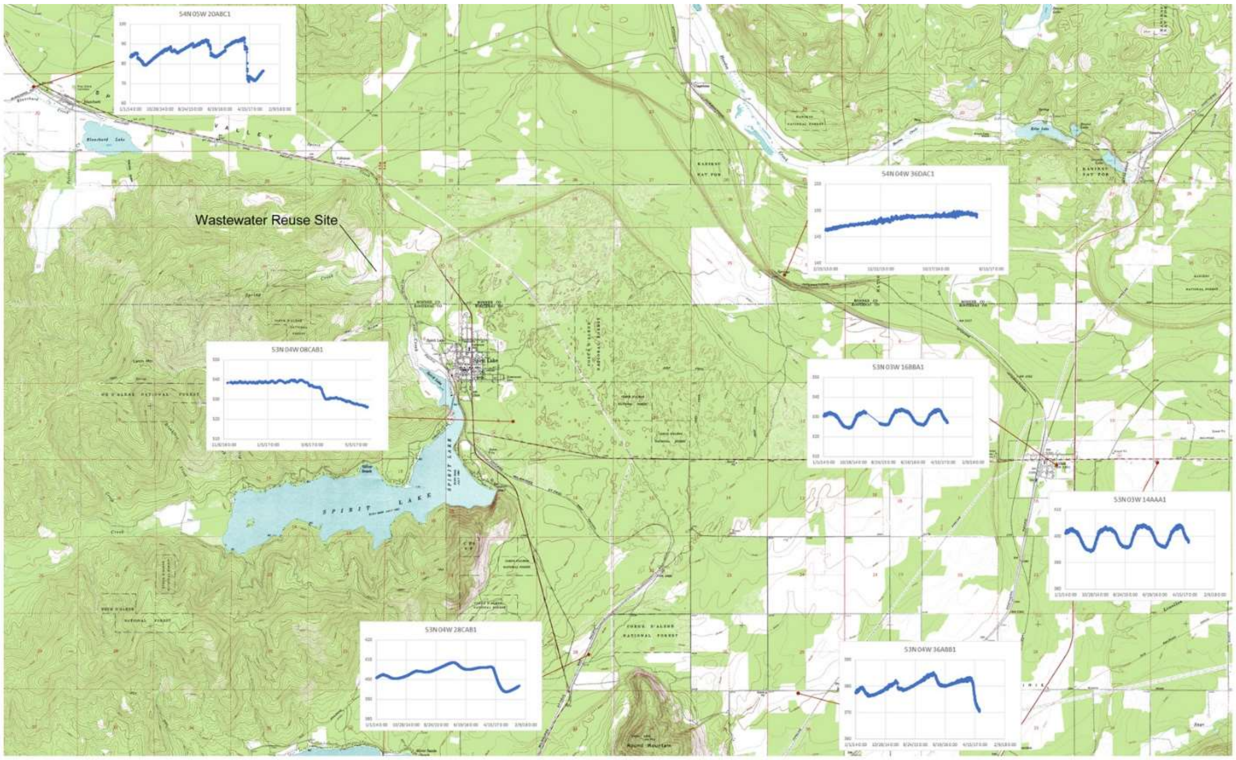


Figure 3. Hydrographs from wells with water level data in the vicinity of Spirit Lake.

The aquifer is recharged by precipitation that falls directly on the land surface above the aquifer, from mountain-front recharge where the crystalline bedrock meets the aquifer, and from lakes like Spirit Lake that were formed when the flood deposits blocked the outflow from stream basins in the bedrock mountains adjacent to the aquifer. The aquifer discharges to the Spokane River. The northwest corner of the Rathdrum Prairie Aquifer is shown in figure 4.

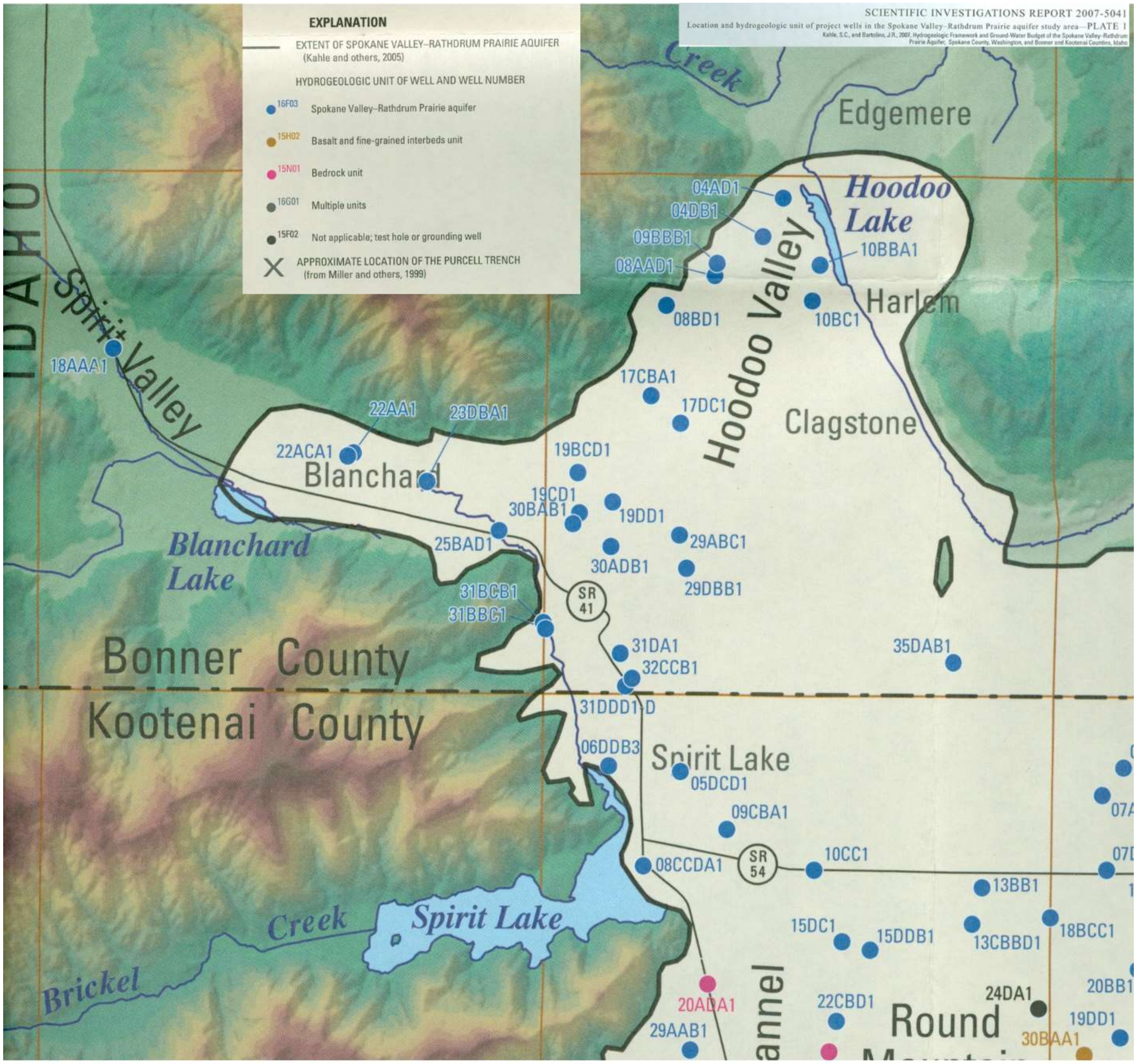


Figure 4. A portion of Plate 1 from USGS Scientific Investigations Report 2007-5042.

At the northern end of the aquifer recharge is coming from Lake Pend Oreille, precipitation that falls directly on the land surface overlying the aquifer and infiltrates, and from mountain front recharge. Ground Generalized ground water flow in the northern end of the Rathdrum Prairie is shown in Figure 5, modified from Hsieh et al. (2007).

In general, ground water flow in the Rathdrum Prairie aquifer near the site is from north to south, more or less parallel to the aquifer boundary. Ground water flows southeast from the arm of the aquifer that extends to the northwest up the Spirit Valley to Blanchard, and then turns to the south near Spirit Lake.

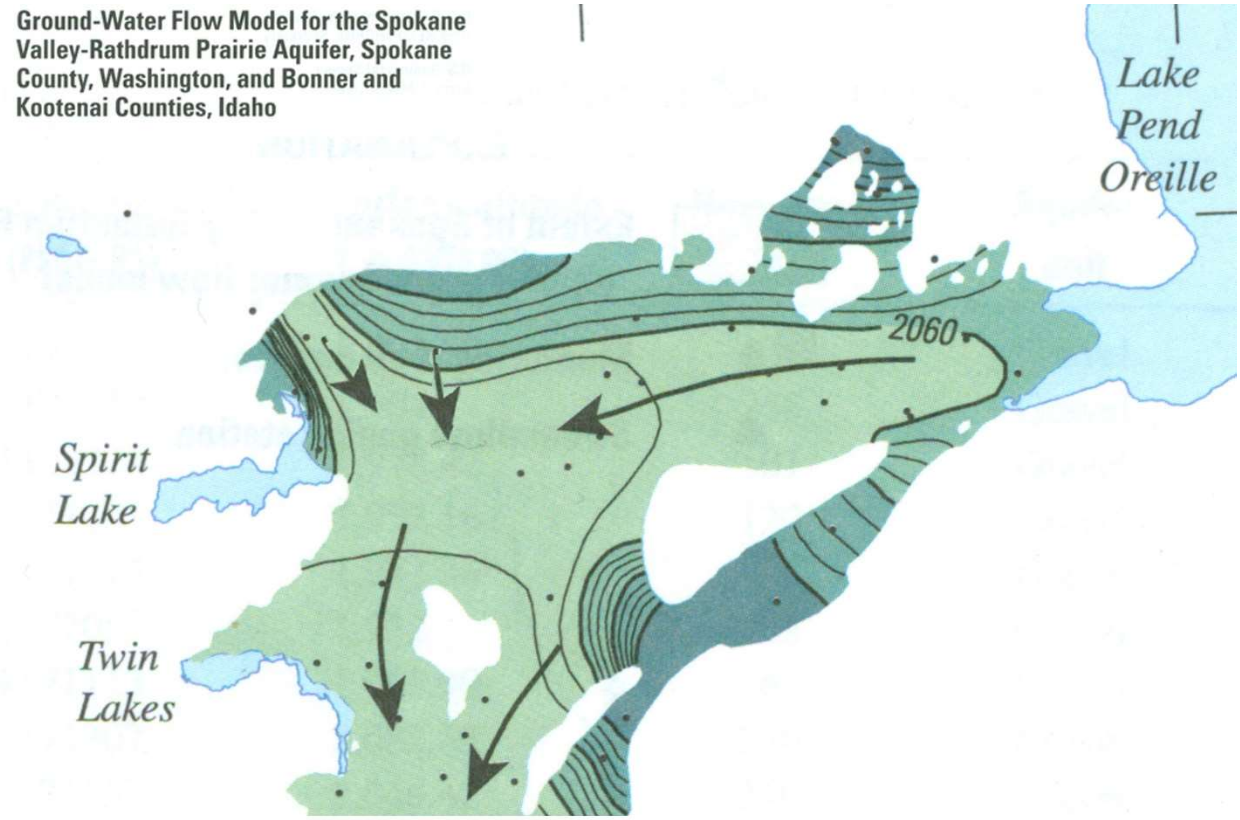


Figure 5. Ground water flow direction in the northern end of the Rathdrum Prairie Aquifer (after Hsieh et al., 2007).

At the site scale, ground water flow direction is likely to be affected by recharge from the Spring Creek watershed and the topography of buried bedrock. Elevation in the Spring Creek watershed ranges from 4624 feet above sea level (asl) at the top of Larch Mountain to 2360 feet asl where Spring Creek flows onto the Rathdrum Prairie. The Spring Creek Watershed covers an area of 3.83 square miles. The valley that Spring Creek flows down forms an embayment of the aquifer into the mountains. Recharge from the Spring Creek valley likely causes a "bulge" in the aquifer flow lines where the mouth of the valley meets the main aquifer.

The closely-spaced water table contour lines along the aquifer boundary near Spirit Lake shown in Figure 5 are caused by shallower water table elevations measured in three wells (wells #265, #247, and #248 in Campbell, 2004) near the aquifer boundary. Two possible explanations for the relatively shallow water table in these wells are: 1) a steep hydraulic gradient at the edge of the aquifer from mountain-front recharge, or 2) the presence of localized, perched aquifers on top of lower permeability layers of unconsolidated deposits. The Bice well (#9 in DEQ, 2014) was drilled using the cable-tool method in 1971. The well was drilled to a depth of 220', and water was present in a layer of fine sand and gravel at 195 – 200 feet below ground surface. A layer of "Blue Clay" is described from 275 - 300 feet bgs in the City of Spirit Lake well that was drilled in 1961-1962, also drilled using the cable-tool method. The City of Spirit Lake well drilled in 1974-1975 describes "clay & sand" at 281 – 292 feet bgs. The Brott and Shacklette wells (section 8) also describe fine-grained silty/sand layers. The Bice and Paisley #11 wells are believed to have been drilled into "perched" aquifers along the edge of the aquifer.

The aquifer boundary has generally been drawn approximately parallel to the geologic contact between the unconsolidated flood deposits of the Rathdrum Prairie and the crystalline bedrock of the mountains. The "approximate" nature of that boundary is illustrated by the Hammond, Paisley, Reforestation, Inc., IDWR, and Frederick wells, which are all inside the generally accepted aquifer boundary but hit bedrock before they reached saturated sand/gravel.

I attempted to refine the location of the aquifer boundary in the vicinity of Spirit Lake. The flood-deposited sands and gravels that comprise the Rathdrum Prairie Aquifer were deposited on a paleo-bedrock topography that likely mimics the existing bedrock topography exposed in the mountains. The bedrock topography immediately adjacent to the Rathdrum Prairie is dominated by generally northeast-southwest trending valleys and ridges. The ridges that separate Spring Creek from Buttersworth Draw most likely continue to the northeast, buried beneath the flood deposits. The same is expected of the valleys that Spring Creek and Buttersworth Draw occupy, they extend beneath the flood deposits. The bedrock ridges are "notched" by what are most likely northwest trending fault zones that have weakened the rock along the fault zones making it more easily eroded. Faults have not been mapped in the Priest River Core-Complex because, unlike in the Belt Supergroup Formation rocks present on the east side of the Rathdrum Prairie, marker beds are not present in the metamorphic rocks. The buried bedrock topography has been subjected to the same erosive forces that have shaped the exposed bedrock surface: primarily continental glaciers and catastrophic floods.

The methodology used to extrapolate the bedrock surface beneath the Rathdrum Prairie was:

1. plot the approximate locations of wells using either survey, GPS from Well Driller's Reports, or legal descriptions from Well Driller's Reports with aerial photograph check;
2. estimate the land surface elevation at the well site using the National Elevation Dataset;
3. calculate bedrock elevation, water table elevation and bottom hole elevation from Well Driller's Report data;
4. extrapolating the bedrock surface as expressed in the surface topography of the mountains to the subsurface beneath the aquifer (Figure 6).

There is some uncertainty with regards to well locations based on Well Driller's Reports. Most of the Well Driller Reports could be linked to developed home sites from aerial photographs and GIS parcel files obtained from the Bonner and Kootenai County web sites. The extrapolations were made by drawing a line along the trend of the ridge top and then continuing the approximate grade of the line into the subsurface.

Proposed Monitoring Well Site Locations

The proposed locations of monitoring wells are shown in Figure 6. Based on the reinterpreted aquifer boundary, up-gradient and down-gradient monitoring wells can be constructed at the site that will allow intrawell comparison of water quality parameters between an up-gradient well or wells (MW-1) and down-gradient wells (MW-2 and MW-3). Depth to water at the down-gradient wells (MW-2 and MW-3) is anticipated to be similar to that measured at the Spirit Lake Business Park well (395 feet bgs). At the upgradient well, depth to water is anticipated to be approximately 315 feet bgs. These water table elevations would result in a hydraulic between the up and down gradient wells of approximately 0.005 ft/ft.

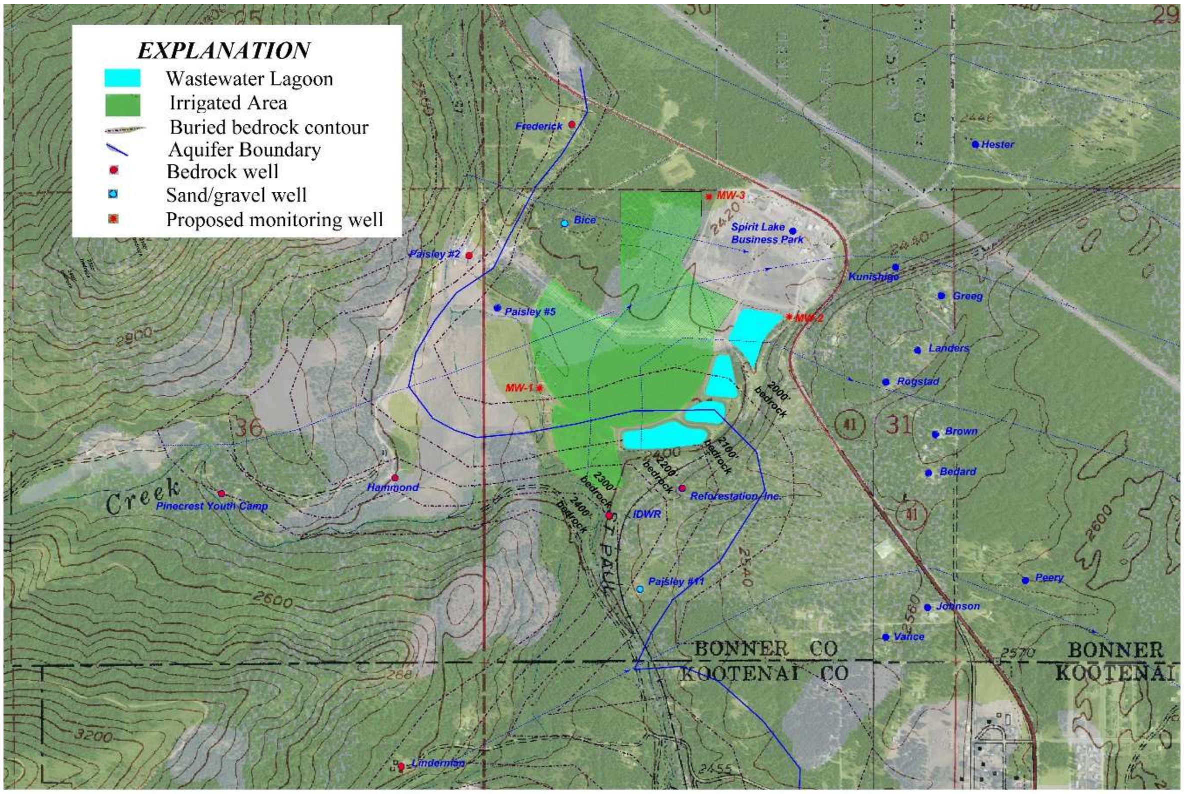


Figure 6. Buried bedrock topography, aquifer boundary, wells and ground water flow lines.

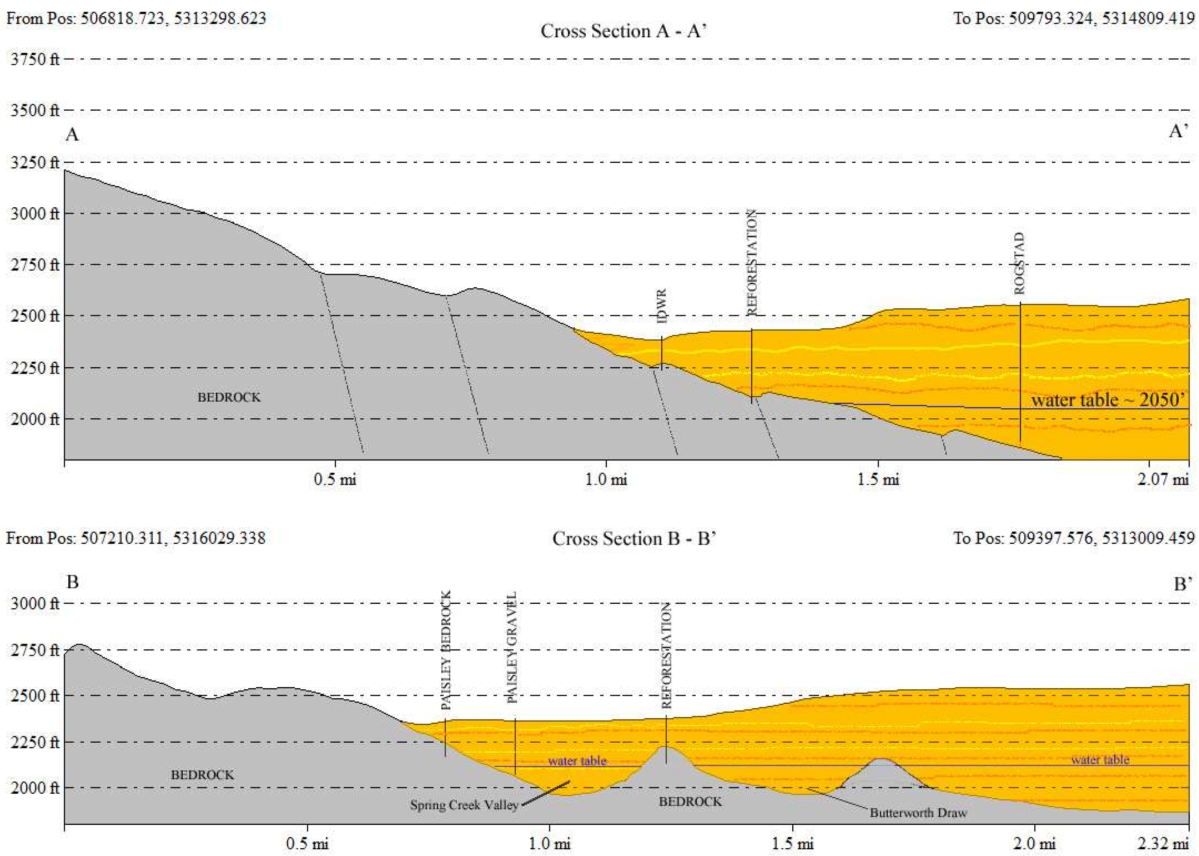


Figure 7. Cross sections through the City of Spirit Lake Wastewater Reuse site.

Project Objectives and Study Area

The objectives of ground water monitoring at the site are to determine if wastewater reuse is affecting water quality in the Rathdrum Prairie aquifer. The study area is the CSL wastewater reuse site and the adjoining Rathdrum Prairie Aquifer (Figure 7). The hydrogeologic features relevant to monitoring are the Rathdrum Prairie Aquifer, Spring Creek, irrigated wastewater reuse areas, and wastewater storage/treatment lagoons.

Parameters to be monitored and Sampling Frequency

The proposed constituents to be monitored are: Nitrate, Chloride, Total Dissolved Solids (TDS), pH, temperature, and depth to water. The climate, hydrogeology, and land use of the site suggests that seasonal variations in water quality are likely to occur. Monthly sampling for three years is proposed to allow use of the Seasonal Kendall Test.

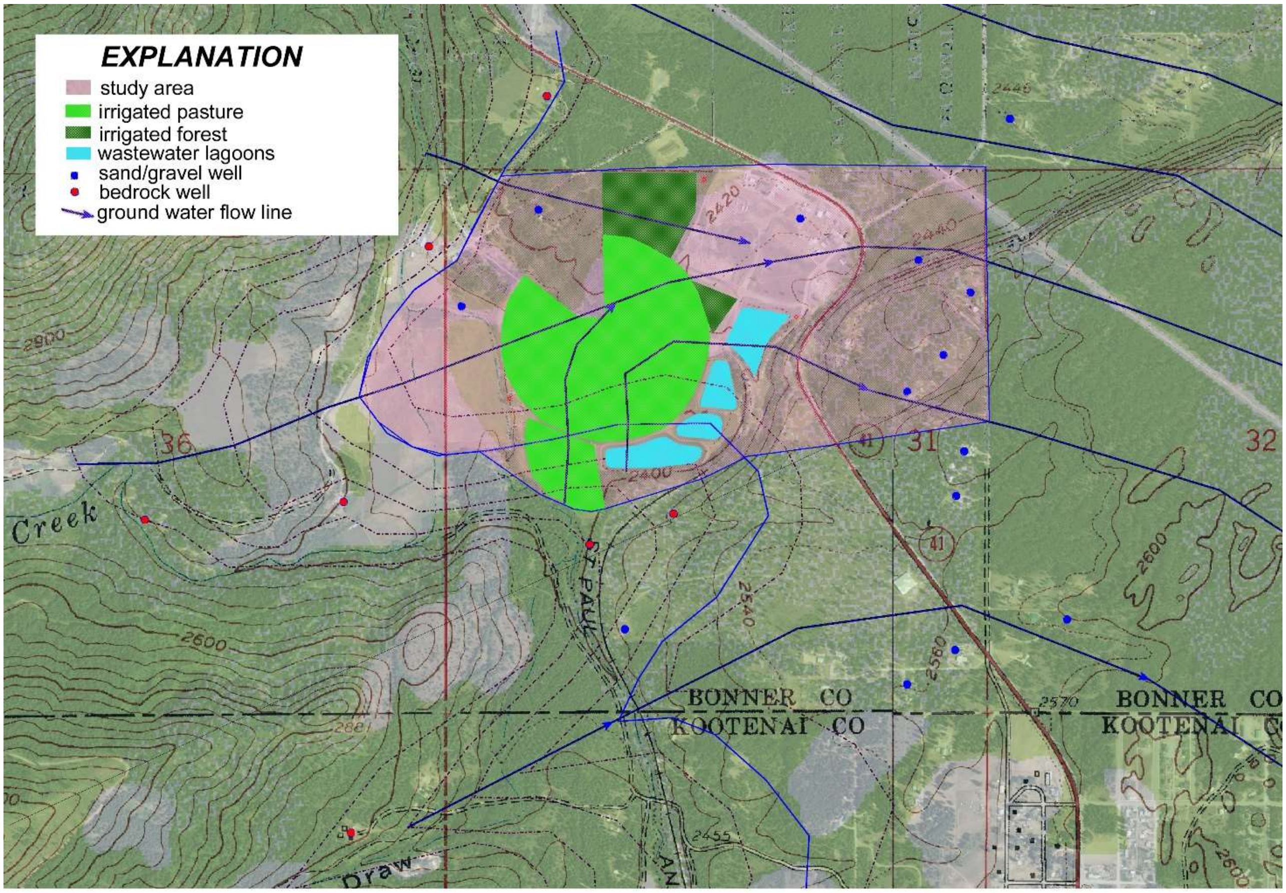


Figure 8. City of Spirit Lake Wastewater reuse site ground water monitoring study area.

Ground Water Monitoring Report

The City of Spirit Lake will submit to DEQ a Ground Water Monitoring Report describing the results of the previous year's ground water monitoring activities, a narrative discussing ground water quality, and a statistical analysis to determine if statistical degradation of ground water quality has occurred. The Ground Water Monitoring Report will be submitted by January 31st of the year following the ground water monitoring activity.

Well Construction

All well construction activities will be in compliance with IDAPA 37.03.09 Well Construction Standards Rules and will be performed by a drilling contractor licensed in the State of Idaho. All well construction activities will be completed under the supervision of an Idaho Registered Professional Geologist.

Drilling and Construction Methods

The monitoring wells will be drilled using the air-rotary method. The air rotary method was chosen because of the likely presence of boulder-sized rocks in the subsurface and the need to advance casing to depths of 300' – 400'. Casing will be advanced as the wells are drilled to prevent collapse of the borehole and to provide a stable environment for construction of the monitoring wells. Drill cutting samples will be collected as the borehole is advanced. Drill cuttings will be disposed of on-site. The monitoring wells will be constructed such that the top of the well casing is approximately two feet above ground surface.

Screened Intervals

The depth and the length of the screen interval of each well will be selected to ensure that water quality samples are obtained from the uppermost portion of the aquifer being monitored. Depth to water information from Well Driller's Reports from nearby wells suggests that the water table in the Rathdrum Prairie Aquifer in the vicinity of the facility occurs at an elevation of approximately 2035 feet asl..

Table 1. Proposed Spirit Lake Wastewater Reuse Site Monitoring Well Information.

Well Name:	UTM Coordinates:	Surface Elev (ft asl):	Estimated Well Depth (ft):	Estimated Depth to Water (ft):	Estimated Water Table Elev. (ft asl):
MW-1	508188, 5314524	2364	335	315	2049
MW-2	509038, 5314768	2436	420	400	2036
MW-3	508764, 5315176	2427	410	391	2036

Seals and Filter Pack

A concrete surface seal, sloped away from the well casing, will be placed around the outer protective casing to prevent migration of contaminants from the surface to the well screen. Bentonite chips or pellets will be used for the sanitary seal above the filter pack. The sand/filter pack will extend above the well screen to prevent entry of grout and/or bentonite into the screened interval. Bentonite grout will be placed above the sanitary seal up to where the surface seal begins.

The surface seal and protective casing will be by constructed be placing a four-foot length of six-inch diameter well casing over the two-inch diameter PVC monitoring well casing. The six-inch diameter well casing will extend from one foot below ground surface to three feet above ground surface. The protective casing will be concreted in by placing a piece of two-foot diameter SONOTUBE over the six-inch casing and pouring the concrete surface seal between the casing and SONOTUBE. The concrete surface seal will be constructed to slope away from the casing.

The approximate dimensions for the monitoring wells are shown in Table 2 and in Figure 9.

Table 2. Values for Parameters listed in Figure 9 for wells with 20' screen length.

Parameter	A. (ft):	B. (in):	C. (ft):	D. (in):	E. (ft):	F. (ft):	G. (ft):	H. (ft):	I. (ft):	J. (ft):	K. (in.):
MW-1	335	8	315	6	20	5	315	5	24	2	6
MW-2	420	8	400	6	20	5	400	5	24	2	6
MW-3	410	8	390	6	20	5	390	5	24	2	6

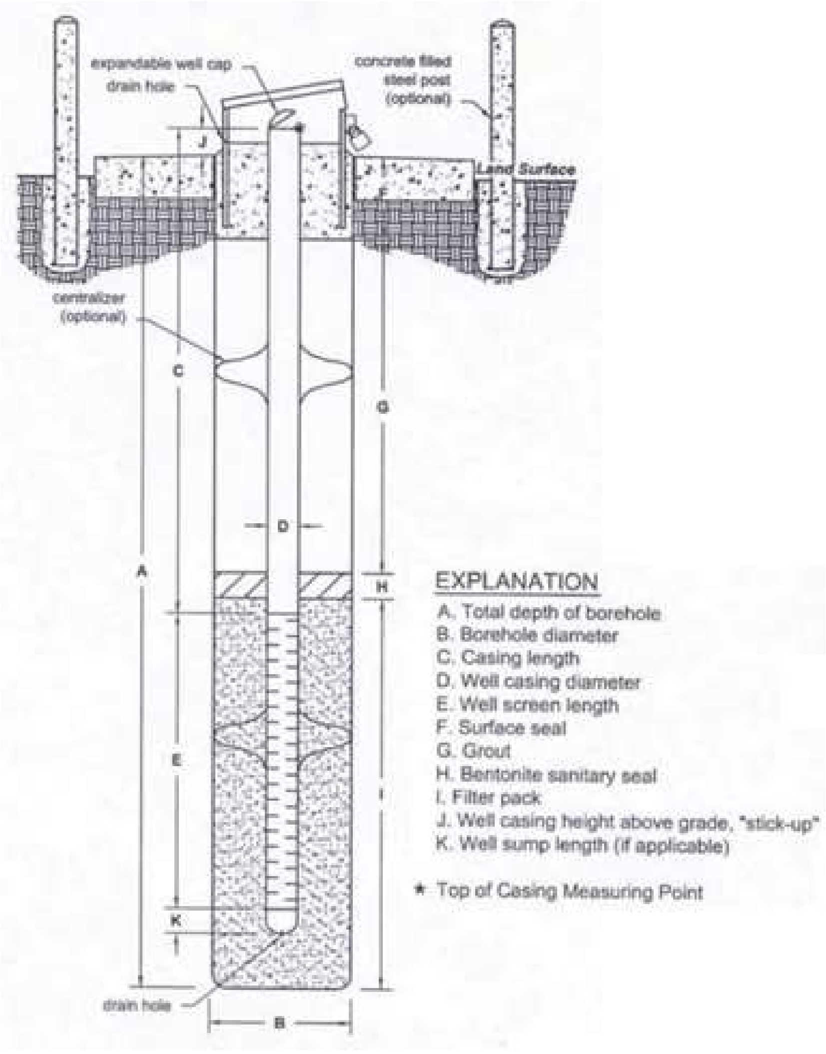


Figure 9. Monitoring well construction parameters listed in Table 2.

Construction Materials

The monitoring wells will be constructed using material that meets or exceeds ASTM Standard F-480. The wells will be constructed using 6-inch diameter steel casing and 20 feet of telescoping stainless-steel well screen. The wells will be equipped with permanent pumps that can be depth-adjusted to allow sampling from a consistent

JAMES A. SEWELL & ASSOCIATES, LLC

600–4th Street West
Newport, Washington 99156
(509) 447-3626
(208) 437-2641
(509) 447-2112 Fax

*Civil Engineering * Electrical Engineering * Land Surveying * Building Inspection * Land Use Planning

June 12, 2018

USDA Rural Development
7830 Meadowlark Way, Suite C3
Coeur d'Alene, ID 83815

Attn: Howard R. Lunderstadt, Community Programs Specialist
Subj: City of Spirit Lake Wastewater Facility Plan
Ref: Facility Plan Resubmittal for Review

Dear Howard:

Enclosed please find the City of Spirit Lake Wastewater Facility Plan resubmittal for your review and approval. The Facility Plan has been revised to reflect comments by DEQ and USDA Rural Development. The following USDA comments from February 12, 2018 have been addressed:

Item 1 – Table 11, Define Standby User, Page 42.
Item 2 – Table 13, Provide Discussion for Commercial versus Residential Flow, Page 43.
Item 3 – Discuss Future Growth versus Historic Growth, Page 46.
Item 4 – Provide Discussion on Mechanical Treatment Plant Option, Page 57.
Item 5 – Provide Discussion on Surface Water Discharge Option, Page 58.
Item 6 – Provide Step by Step Plan and Timeframe for Improvements, Page 103.
Item 7 – Explain Short Lived Asset Reserve Requirements, Page 98.

Your review of the enclosed information would be much appreciated. Please contact me with any questions at 509-447-3626 or kkoesel@jasewell.com.

Sincerely,

JAMES A. SEWELL & ASSOCIATES, LLC

By
Kevin Koesel, P.E.

Encl:
pc: City of Spirit Lake, Renee Eastman, Ann Clapper
File

depth beneath the water table, and sample taps. The wells will be wired so that they can be run using a portable generator. All other materials used (filter/sand pack, sanitary seal, and bentonite chips, pellets, and grout) will be NSF/ANSI Standard 60 certified.

Well Development

The monitoring wells will be developed until clean, non-turbid water can be removed from the formation. The criteria for determining when each well is sufficiently developed will be that field-measured water quality parameters (pH and temperature) are stable and the water is non-turbid. The wells will be developed using hand bailers and a 12-volt water pump. The wells will initially be hand bailed to remove as much suspended material from the water column as possible. Following hand bailing, the pump will be lowered into the well and slowly raised and lowered throughout the length of the screened interval while pumping. For each monitoring well installed, the development method, flow rate, length of time, and the criteria used for ending development will be documented.

Sincerely,

John Monks, P.G., L.H.G.
Hydrogeologist

REGISTERED PROFESSIONAL GEOLOGIST
JOHN
MONKS
916
STATE OF IDAHO