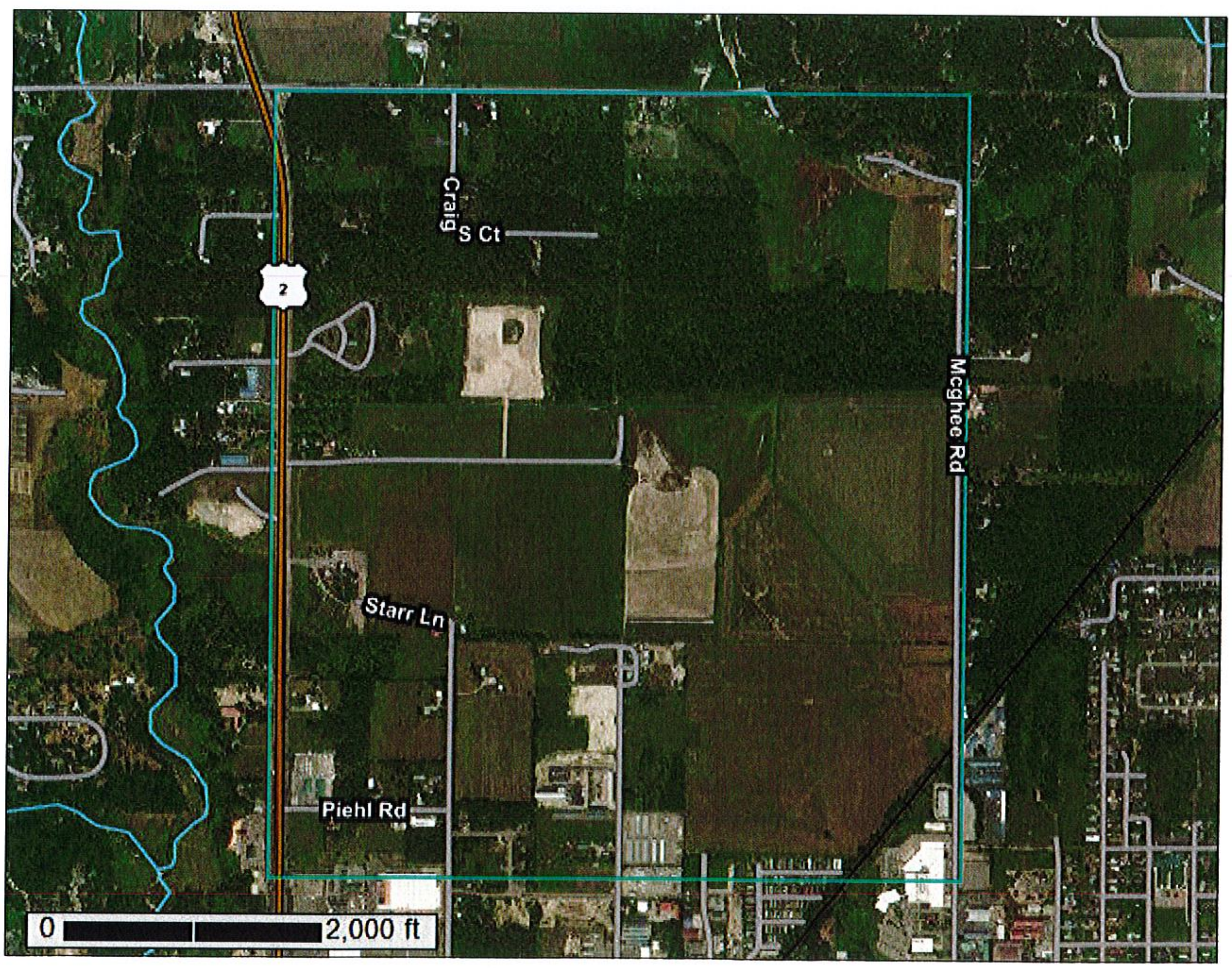
United States Department of Agriculture

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



June 13, 2022

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.

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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.

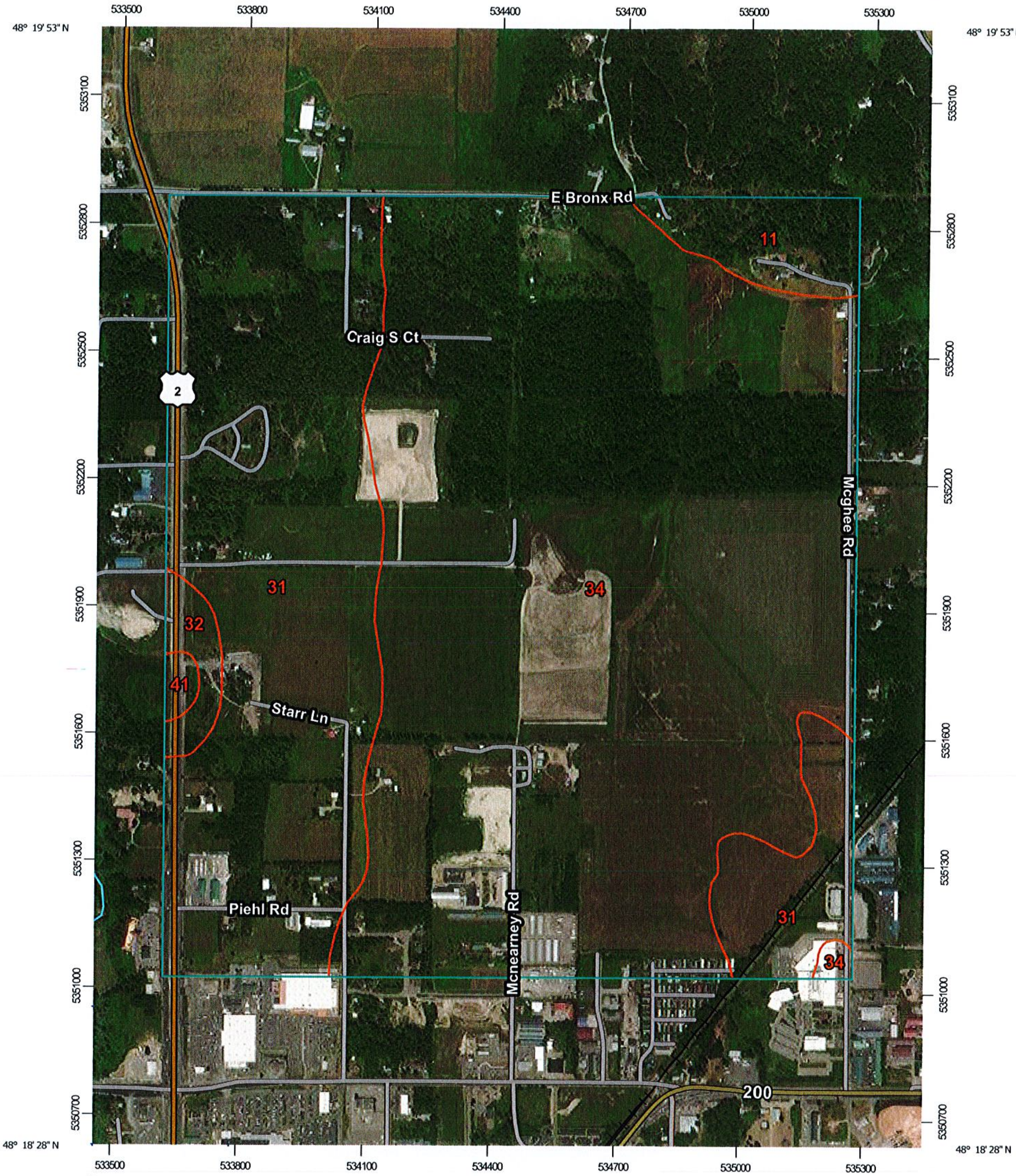
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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: 1:12,800 if printed on A portrait (8.5" x 11") sheet.

N

0 150 300 600 900 Meters

0 500 1000 2000 3000 Feet

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.

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 17, Sep 9, 2021

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

Date(s) aerial images were photographed: Aug 15, 2010—Aug 23, 2016

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

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
11	Dufort-Rock outcrop complex, 5 to 45 percent slopes	23.2	3.1%
31	Mission silt loam, 0 to 2 percent slopes	243.3	32.2%
32	Mission silt loam, 2 to 12 percent slopes	9.4	1.2%
34	Odenson silt loam, 0 to 2 percent slopes	476.7	63.1%
41	Pywell muck, 0 to 1 percent slopes, occasionally flooded	2.7	0.4%
Totals for Area of Interest		**755.3**	**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

11—Dufort-Rock outcrop complex, 5 to 45 percent slopes

Map Unit Setting

National map unit symbol: 545c
Elevation: 1,800 to 5,000 feet
Mean annual precipitation: 24 to 40 inches
Mean annual air temperature: 43 to 48 degrees F
Frost-free period: 70 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Dufort and similar soils: 45 percent
Rock outcrop: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dufort

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over till derived from granite and/or gneiss and/or schist

Typical profile

A - 0 to 13 inches: ashy silt loam
Bt - 13 to 24 inches: gravelly silt loam
2C - 24 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 5 to 45 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 supply, 0 to 60 inches: Moderate (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F043AY521WA - Warm-Frigid, Moist- Xeric Loamy Foothills/ Mountainsides, ashy surface (Grand Fir Warm Dry Shrub) Abies grandis - Pseudotsuga menziesii / Physocarpus malvaceus - Symphoricarpos albus
Other vegetative classification: grand fir/ninebark (CN506)
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: bedrock

Properties and qualities

Slope: 5 to 45 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: No

Minor Components

Ardtoo

Percent of map unit: 5 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: grand fir/ninebark (CN506)
Hydric soil rating: No

Treble

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F043AY519WA - Warm-Frigid, Xeric, Loamy Slopes, low AWC subsoils (Douglas-Fir/Warm Dry Shrub) Pseudotsuga menziesii / Physocarpus malvaceus - Symphoricarpos albus
Other vegetative classification: Douglas-fir/ninebark (CN260)
Hydric soil rating: No

Lenz

Percent of map unit: 5 percent
Landform: Hillslopes, ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Other vegetative classification: Douglas-fir/ninebark (CN260)
Hydric soil rating: No

Bonner

Percent of map unit: 5 percent
Landform: Outwash terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

Pend oreille

Percent of map unit: 5 percent
Landform: Hillslopes, ravines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Other vegetative classification: western hemlock/queencup beadlily (CN570)
Hydric soil rating: No

31—Mission silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 5462
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 130 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Mission and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mission

Setting

Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
Bw - 3 to 12 inches: silt loam
2Btx - 12 to 21 inches: silt loam
2E - 21 to 33 inches: silt
2Bt - 33 to 48 inches: silt loam
3C - 48 to 67 inches: fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 10 to 20 inches to fragipan
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)

Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F043AY527WA - Warm-Frigid, Udic, Loamy Foothills/Valleys, high water table (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Colburn

Percent of map unit: 5 percent
Landform: Stream terraces, alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Mission, moderately well drained

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Selle

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Microfeatures of landform position: Shorelines
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Bonner

Percent of map unit: 5 percent
Landform: Outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

Hoodoo

Percent of map unit: 3 percent
Landform: Drainageways, flood plains

Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Odenson

Percent of map unit: 2 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

32—Mission silt loam, 2 to 12 percent slopes

Map Unit Setting

National map unit symbol: 5463
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 130 days
Farmland classification: Farmland of statewide importance, if drained

Map Unit Composition

Mission and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mission

Setting

Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
Bw - 3 to 12 inches: silt loam
2Btx - 12 to 21 inches: silt loam
2E - 21 to 33 inches: silt
2Bt - 33 to 48 inches: silt loam
3C - 48 to 67 inches: fine sand

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: 10 to 20 inches to fragipan
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F043AY527WA - Warm-Frigid, Udic, Loamy Foothills/Valleys, high water table (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Wrencoe

Percent of map unit: 5 percent
Landform: Flood plains
Microfeatures of landform position: Shorelines
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Colburn

Percent of map unit: 5 percent
Landform: Alluvial fans, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Selle

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Microfeatures of landform position: Shorelines
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Mission, moderately well drained

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Bonner

Percent of map unit: 5 percent
Landform: Outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Convex
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

Hoodoo

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

34—Odenson silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 5465
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: 80 to 130 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Odenson and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Odenson

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

A - 0 to 9 inches: silt loam
2Bg - 9 to 18 inches: silty clay loam
2Bgk - 18 to 35 inches: silty clay loam
3Cg - 35 to 46 inches: silt loam
4Cgk - 46 to 57 inches: silty clay
5Cg - 57 to 60 inches: very fine sandy loam
6Cgk - 60 to 62 inches: silty clay
7Cg - 62 to 65 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: R043AY512ID - Warm-Frigid, Aquic-Udic, Loamy Floodplains (wet,DECA/CAREX)
Hydric soil rating: Yes

Minor Components

Pywell

Percent of map unit: 5 percent
Landform: Basin floors
Hydric soil rating: Yes

Colburn

Percent of map unit: 5 percent
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Selle

Percent of map unit: 5 percent
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Mission

Percent of map unit: 5 percent
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Wrencoe

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Hoodoo

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

41—Pywell muck, 0 to 1 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2x6t1
Elevation: 2,050 to 2,360 feet
Mean annual precipitation: 27 to 35 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 60 to 120 days

Farmland classification: Prime farmland if drained

Map Unit Composition

Pywell, occasionally flooded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pywell, Occasionally Flooded

Setting

Landform: Depressions, flood plains
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Herbaceous organic material over woody organic material

Typical profile

Oa1 - 0 to 11 inches: muck
Oa2 - 11 to 42 inches: muck
Oe - 42 to 60 inches: mucky peat

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 7.09 in/hr)
Depth to water table: About 0 to 48 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 26.9 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R043AY511ID - Frigid, Aquic, Organics, Depressions and Seeps (CAREX/SPHAG)
Hydric soil rating: Yes

Minor Components

Capehorn

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/devil's club (CN550)
Hydric soil rating: Yes

Wrencoe, poorly drained

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R044AY601WA - WET MEADOW 16-24 PZ
Other vegetative classification: willow series - wetland (SW10)
Hydric soil rating: Yes

Hoodoo, somewhat poorly drained

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

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Appendix B

Background

McGhee subdivision will be built on approximately one section of land just north of Sandpoint, Idaho. The land is currently between Sand Creek to the west and Boyer Slough to the east. This drainage flows into a ditch that runs parallel to a railroad and flows off site through existing culverts. According to the City of Ponderay Code: Stormwater Management Ordinance Chapter 4 Section 8-4-8, the development is required to maintain existing conveyance for the drainage. Additionally, the city Code specifies that peak flows should be calculated using TR-55 or some other method approved by the city engineer for drainages larger than 10 acres. This report is a summary of the methods used to evaluate the 100-year stormwater event for the local watershed surrounding the McGhee development.

Hydrologic analysis

Watershed Modeling System (WMS) Version 11.1, developed by Aquaveo, was utilized to model two hydrologic conditions: average and wet. These are represented by the Antecedent Moisture Condition numbers (AMC), which are coefficients calculated based on land use and soil data. AMC II indicates average soil saturation and AMC III indicates higher soil saturation. Three methods were used to evaluate the 100-year flow and respective hydrographs for the drainage: HEC-1 and National Stream Statistics with United States Geological Survey Regional Regression Equations and TR-55.

1. Preliminary Peak Flow Estimate

Picture and video data from a site visit in March of 2022 indicate that rain-on-snow storm events may result in significant water accumulation and flow through the site. A rough estimate using hydraulic toolbox was performed using the parameters in Table 1. These parameters were based on assumptions informed by the following image of flooding on the site (Figure 1). ***The preliminary estimation of flow was approximately 160 cfs.***

TABLE 1. HYDRAULIC TOOLBOX ESTIMATION PARAMETERS

Parameter	Value
Side Slope (H:V)	3
Channel Width (ft)	5
Longitudinal Slope (ft/ft)	0.002
Manning's n	0.025
Depth (ft)	3

FIGURE 1. MARCH 2022 FLOODING OF SITE (LOOKING NORTH)

Model Setup (WMS)

A 30-meter resolution DEM was downloaded from USGS. Using this terrain data, the TOPAZ program within WMS was used to compute flow directions and flow accumulations. Outlets were placed in flow accumulation lines at the approximate locations where runoff from the site flows into the existing culverts. The outlet points allowed the drainage basins to be delineated, using the "Delineate Basins" tool. This resulted in two basins. The South basin flows into an outlet on the southeast corner of the property and, the North basin flows into an outlet at the intersection of the railroad and McGhee Road. Once the basins were delineated, the land cover and hydrologic soil data were needed to calculate basin characteristics.

Curve Number Estimation

The land cover was sourced from the U.S. Geological Survey National Land Cover Database (NLCD). The soil coverage data was downloaded from the Soil Survey Geographic Database (SSURGO) and was joined to the built-in NRCS database to determine the hydrologic soil group. Any null values in the soil database were assumed to be the dominant soil group within the watershed, which was determined to be soil group D. The period with the most precipitation occurs during months with snow cover. Therefore, it was assumed there was no initial abstraction. The text file of curve numbers for the vector land use data was downloaded from Aquaveo's WMS Wiki site. In the models representing the rain on snow condition, the CNs used were the CNs for antecedent moisture conditions (AMC) III (i.e., wet conditions).

Precipitation Inputs

Based on the geographical location of the basins, the Soil Conservation Service (SCS) storm was estimated to be Type II. According to the Online StreamStats Tool, the average annual precipitation for the basin surrounding the property was 32.8 inches. The precipitation depths for a 24-hour storm were obtained from National Oceanic and Atmospheric Administration (NOAA). The precipitation depths from the NOAA online precipitation estimates tool, derived from Atlas 2, are summarized in **Table 2**.

Table 2. Precipitation depths for Various storms

Frequency Storm (24-hr)	Precipitation Depth (inches)
2-year	1.90
25-year	2.94
100-year	3.60

Delineated Basins

The North and South basin outlines are shown in Figure 2, along with the preliminary plat for Mcghee subdivision. See Appendix A for Basin Maps.

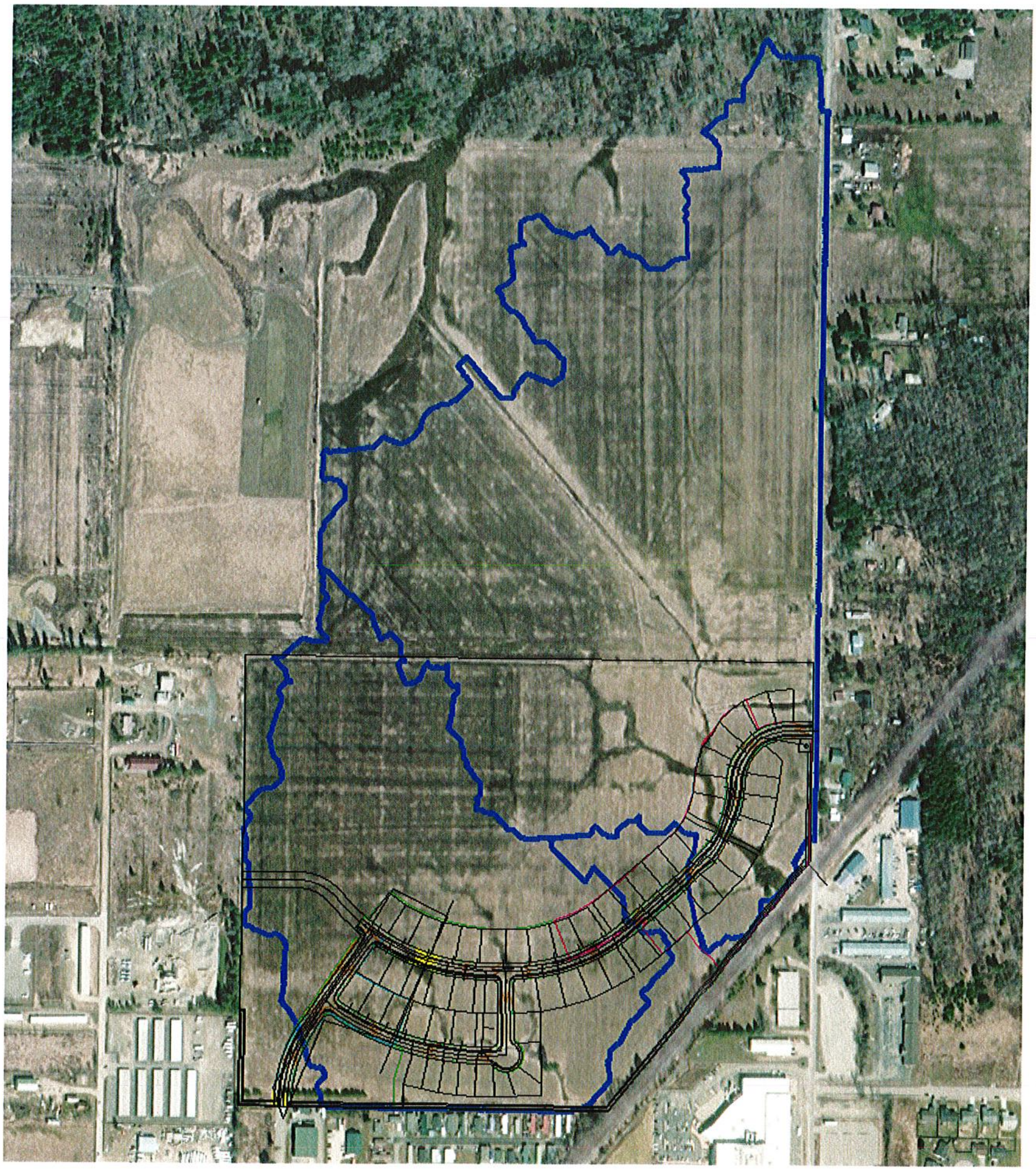

Figure 2. WMS Basin Delineation

The computed basin characteristics for the average (AMC II) and wet conditions (AMC III) are summarized in Table **3**.

TABLE 3. SUMMARIZED BASIN CHARACTERISTICS

Basin	Average CN (AMC II)	Wet CN (AMC III)	Area (acres)
North	74	93	75
South	75	86	31

Watershed Modeling Software (WMS) Methods

HEC-1

HEC-1 is a 1-D hydrologic analysis model developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. It was designed to simulate surface runoff response of a river basin due to precipitation from a single storm using a set of parameters that simulate the hydrologic response of an area of interest. A hydrologic analysis was run using WMS's interface of HEC-1 on the McGhee basins with the following model-specific assumptions:

TABLE 4. HEC-1 COMPONENTS FOR MCGHEE SUBDIVISION

Basin Data	
Area	*Subbasin Areas (mi^2): North, South*
Base Flow	*None*
Precipitation	
Basin Average (PB)	*Precipitation depth input per frequency storm*[1]
Rainfall Distribution	*Type II - 24 hour*
Loss Method	
SCS Curve Number	*Varies based on AMC*[2]
Unit Hydrograph Methods	
SCS Dimensionless (UD)	*Lag Time: Map Data (Time Computation arcs)*
Job Control	
Simulation Run Time	*24 hours*
Time Interval	*15 Minutes*

[1]*See Table 1*

[2]*See Table 2*

National Stream Statistics (NSS)

National Stream Statistics is a regression-based hydrologic model developed using National Flood Frequency Program (NFF) equations compiled through a joint effort by the USGS, Federal Highway Administration, and Federal Emergency Management Agency (FEMA). The NFF equations are used to estimate a peak flood discharge and a typical hydrograph for a given frequency interval on an unregulated watershed. A hydrologic analysis was run using the NSS method with the following model-specific assumptions:

- Max Flood Region: 13
- Idaho Peak Flow Region 1 and 2, 2016 regression equations
- Mean annual precipitation: 32.8 inches. For wet conditions, 66.8 inches.

According to the USGS Scientific Investigation Report for estimating peak flow statistics in Idaho, Region 1 and 2 should be used for the town of Sandpoint. The regression equation for this region requires two variables: drainage area and mean annual precipitation. The minimum value for drainage area is 1.11 square miles, yet the largest basin measures approximately 0.12 square miles. The results are likely to be inaccurate because the delineated basins are not within the recommended drainage area.

TR-55

Technical Release 55 (TR-55) is a simplified method of calculating hydrologic data for small watersheds in the US. The program was developed by Soil Conservation Service and incorporates the Service's procedures. The parameters used are summarized in **Table 5**.

TABLE 5. TR-55 MODEL PARAMETERS

Parameter	Basin	
	North	South
Time of Concentration (TC) (hr)	0.96	0.98
Drainage Area (Am)(mi^2)	0.12	0.05
Rainfall (P) (in)	Varies based on AMC	
Runoff Curve Number (CN)	Varies based on AMC	
Rainfall Distribution	Type II	Type II

Hydrologic Analysis Results

The results for the three methods modeled are shown below.

1. HEC-1 Results

TABLE 6. HEC-1 PEAK FLOW RESULTS

Parameter	AMC II		AMC III	
	100-year			
	North	South	North	South
Peak Flow (cfs)	36	19	74	17
Volume (ac*ft)	9	4	14	4
Time to Peak (min)	780	765	750	765

2. NSS Results

TABLE 7. NSS PEAK FLOW RESULTS

Parameter	100-year	
	North	South
Peak Flow (cfs)	6	3

According to the USGS Scientific Investigation Report for estimating peak flow statistics in Idaho, Region 1 and 2 should be used for the town of Sandpoint. The regression equation for this region requires two variables:

drainage area and mean annual precipitation. The minimum value for drainage area is 1.11 square miles, yet the largest basin measures approximately 0.12 square miles. This resulted in high standard error of prediction with peak flows ranging from 2cfs to 40cfs.

TR-55 Results

TABLE 6. TR-55 PEAK FLOW RESULTS

TR-55 Peak Flow (cfs)	
North	South
Wet Rain Conditions (AMC III) 100-year	
130	39

3. Result Comparison

The peak flow values for various recurrence intervals were compared for the three methods modeled. The results are shown in **Table 7** and **Table 8**, for the respective outlet locations. The NSS results appear to underestimate flow. For the wet condition, the HEC-1 and TR-55 results appear more similar in magnitude to observed storm events and are likely more representative of the actual conditions.

TABLE 7. PEAK FLOW COMPARISON NORTH OUTLET

Method	AMC II Peak Flow (cfs)	AMC III Peak Flow (cfs)
	100-year	
HEC-1	36	74
NSS	3	6
TR-55	6	130

TABLE 8. PEAK FLOW COMPARISON SOUTH OUTLET

Method	AMC-II Peak Flow (cfs)	AMC-III Peak Flow (cfs)
	100-year	
HEC-1	19	17
NSS	2	3
TR-55	4	39

Recommendation

It is recommended that the Design Flow is based on the TR-55 or HEC-1 results as they are more in line with the observed rain-on-snow flooding, and they are more conservative. For the purposes of the hydrologic report, the HEC-1 results were used because they provided hydrographs and hydrographs were needed for the volume analysis to size the detention basins. The TR-55 results are the most conservative and may be ideal for land development purposes.

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 20 cfs

Maximum Flow: 200 cfs

Table 1 - Summary of Culvert Flows at Crossing: Downstream UP Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2124.40	0.00	0.00	0.00	1
2126.89	20.00	20.00	0.00	1
2129.52	40.00	40.00	0.00	1
2132.53	60.00	51.14	8.26	8
2132.57	80.00	49.60	29.92	5
2132.61	100.00	48.21	51.34	4
2132.63	120.00	46.95	72.88	4
2132.66	140.00	45.77	93.67	3
2132.68	160.00	44.67	114.98	3
2132.70	180.00	43.63	136.20	3
2132.72	200.00	42.63	157.30	3
2132.50	51.81	51.81	0.00	Overtopping

Rating Curve Plot for Crossing: Downstream UP Culvert

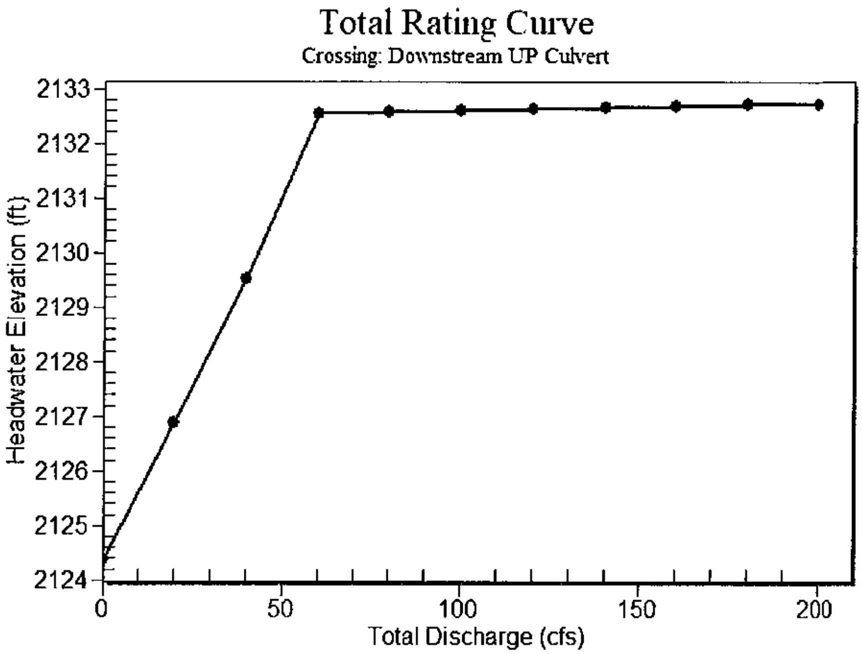

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2124.40	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
20.00	20.00	2126.89	2.493	1.016	1-S2n	1.312	1.518	1.312	1.868	7.665	2.769
40.00	40.00	2129.52	5.116	4.916	4-FFf	2.500	2.129	2.500	2.624	8.149	3.296
60.00	51.14	2132.53	7.459	8.131	4-FFf	2.500	2.314	2.500	3.179	10.419	3.645
80.00	49.60	2132.57	7.092	8.175	4-FFf	2.500	2.294	2.500	3.631	10.104	3.913
100.00	48.21	2132.61	6.774	8.208	4-FFf	2.500	2.275	2.500	4.019	9.822	4.134
120.00	46.95	2132.63	6.494	8.235	4-FFf	2.500	2.257	2.500	4.362	9.564	4.324
140.00	45.77	2132.66	6.241	8.260	4-FFf	2.500	2.238	2.500	4.672	9.324	4.491
160.00	44.67	2132.68	6.012	8.283	4-FFf	2.500	2.220	2.500	4.956	9.100	4.641
180.00	43.63	2132.70	5.801	8.305	4-FFf	2.500	2.201	2.500	5.219	8.887	4.777
200.00	42.63	2132.72	5.605	8.325	4-FFf	2.500	2.182	2.500	5.465	8.684	4.903

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Straight Culvert

Inlet Elevation (invert): 2124.40 ft, Outlet Elevation (invert): 2122.50 ft

Culvert Length: 69.28 ft, Culvert Slope: 0.0274

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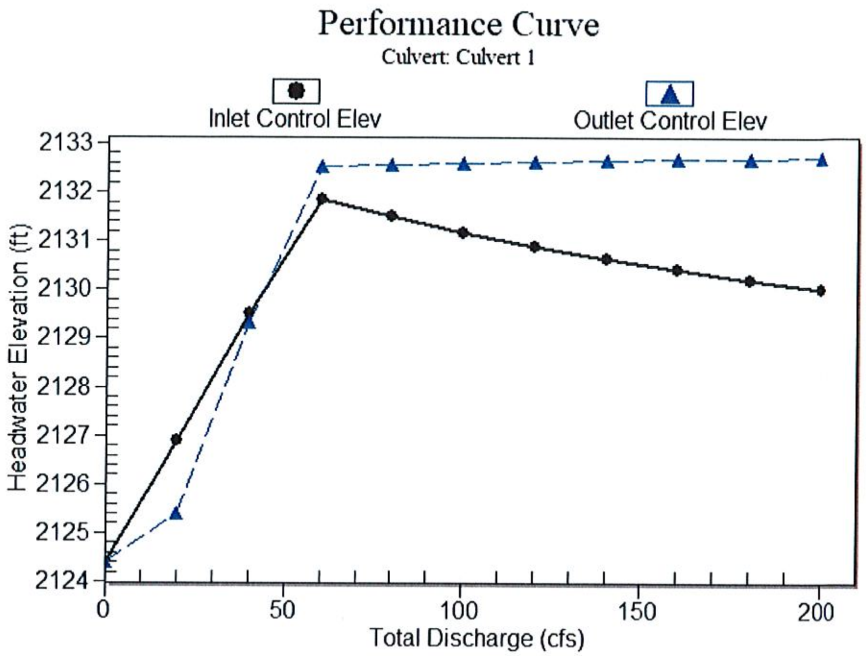
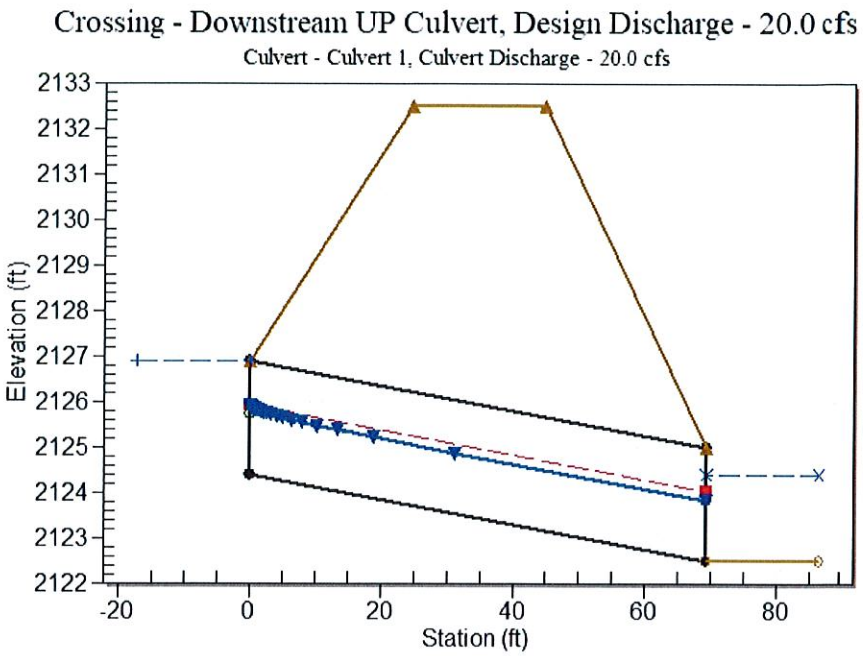
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



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Inlet Station: 0.00 ft

Inlet Elevation: 2124.40 ft

Outlet Station: 69.25 ft

Outlet Elevation: 2122.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Downstream UP Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	2122.50	0.00	0.00	0.00	0.00
20.00	2124.37	1.87	2.77	0.50	0.43
40.00	2125.12	2.62	3.30	0.70	0.45
60.00	2125.68	3.18	3.64	0.85	0.46
80.00	2126.13	3.63	3.91	0.97	0.46
100.00	2126.52	4.02	4.13	1.08	0.47
120.00	2126.86	4.36	4.32	1.17	0.47
140.00	2127.17	4.67	4.49	1.25	0.48
160.00	2127.46	4.96	4.64	1.33	0.48
180.00	2127.72	5.22	4.78	1.40	0.48
200.00	2127.96	5.46	4.90	1.47	0.49

Tailwater Channel Data - Downstream UP Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 ft

Side Slope (H:V): 1.00 (_:1)

Channel Slope: 0.0043

Channel Manning's n: 0.0350

Channel Invert Elevation: 2122.50 ft

Roadway Data for Crossing: Downstream UP Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 2132.50 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 20 cfs

Maximum Flow: 200 cfs

Table 4 - Summary of Culvert Flows at Crossing: Upstream UP Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2128.10	0.00	0.00	0.00	1
2130.73	20.00	20.00	0.00	1
2132.53	40.00	33.85	5.84	39
2132.57	60.00	32.31	27.10	5
2132.60	80.00	29.99	49.44	4
2132.63	100.00	27.81	71.97	4
2132.66	120.00	25.70	93.62	3
2132.68	140.00	23.62	115.94	3
2132.71	160.00	21.53	138.25	3
2132.73	180.00	19.40	160.50	3
2132.75	200.00	17.16	182.82	3
2132.50	33.73	33.73	0.00	Overtopping

Rating Curve Plot for Crossing: Upstream UP Culvert

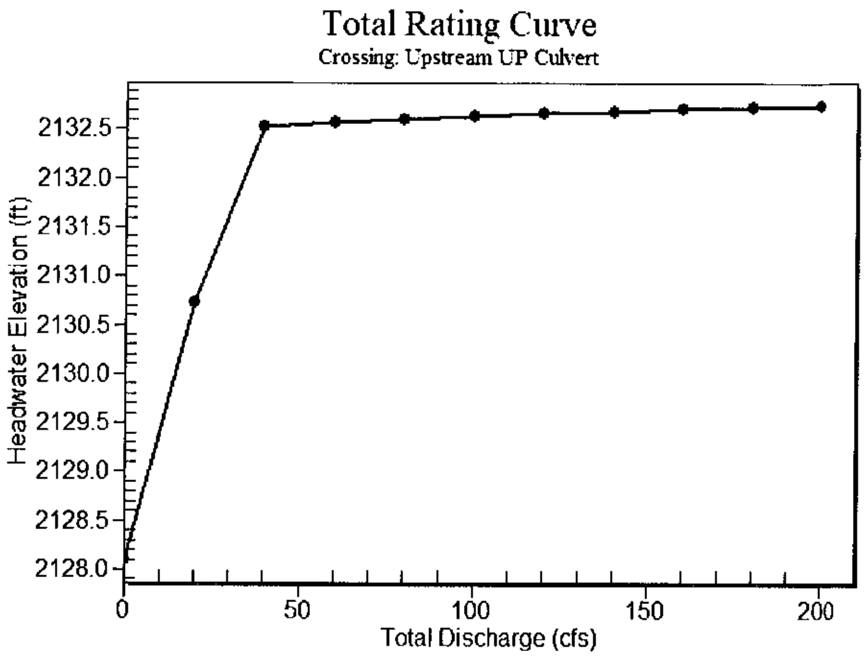

Table 5 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2128.10	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
20.00	20.00	2130.73	2.513	2.627	7-M2c	1.748	1.518	1.518	1.387	6.413	2.677
40.00	33.85	2132.53	4.139	4.425	7-M2t	2.500	1.978	2.039	2.039	7.898	3.249
60.00	32.31	2132.57	3.919	4.470	4-FFf	2.500	1.935	2.500	2.535	6.582	3.621
80.00	29.99	2132.60	3.610	4.505	4-FFf	2.500	1.867	2.500	2.949	6.110	3.904
100.00	27.81	2132.63	3.340	4.534	4-FFf	2.500	1.798	2.500	3.309	5.665	4.135
120.00	25.70	2132.66	3.097	4.560	4-FFf	2.500	1.728	2.500	3.630	5.235	4.332
140.00	23.62	2132.68	2.874	4.584	4-FFf	2.022	1.655	2.500	3.922	4.813	4.506
160.00	21.53	2132.71	2.661	4.605	4-FFf	1.854	1.577	2.500	4.191	4.385	4.660
180.00	19.40	2132.73	2.456	4.628	4-FFf	1.708	1.494	2.500	4.442	3.952	4.800
200.00	17.16	2132.75	2.249	4.648	4-FFf	1.567	1.401	2.500	4.677	3.496	4.929

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Straight Culvert

Inlet Elevation (invert): 2128.10 ft, Outlet Elevation (invert): 2127.30 ft

Culvert Length: 69.25 ft, Culvert Slope: 0.0116

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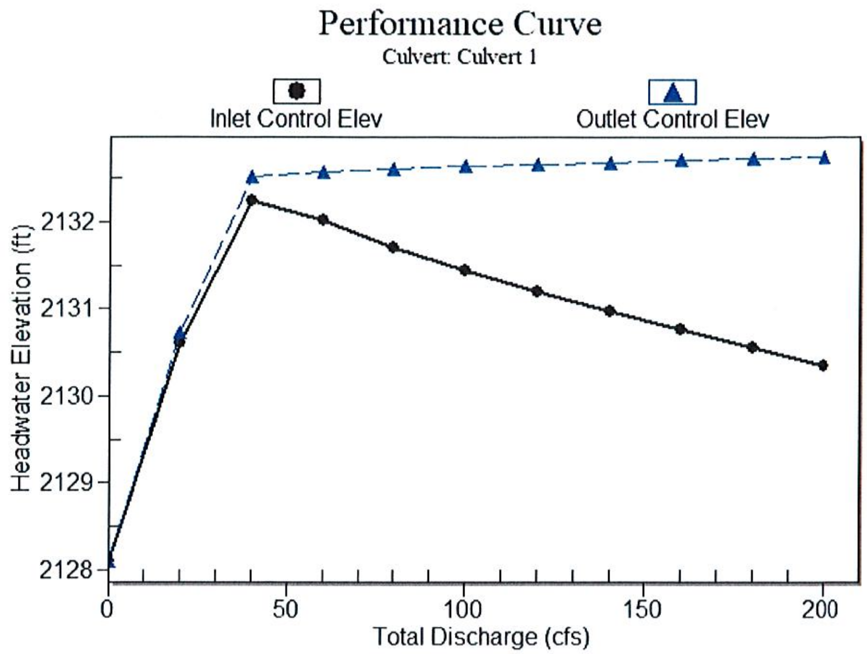
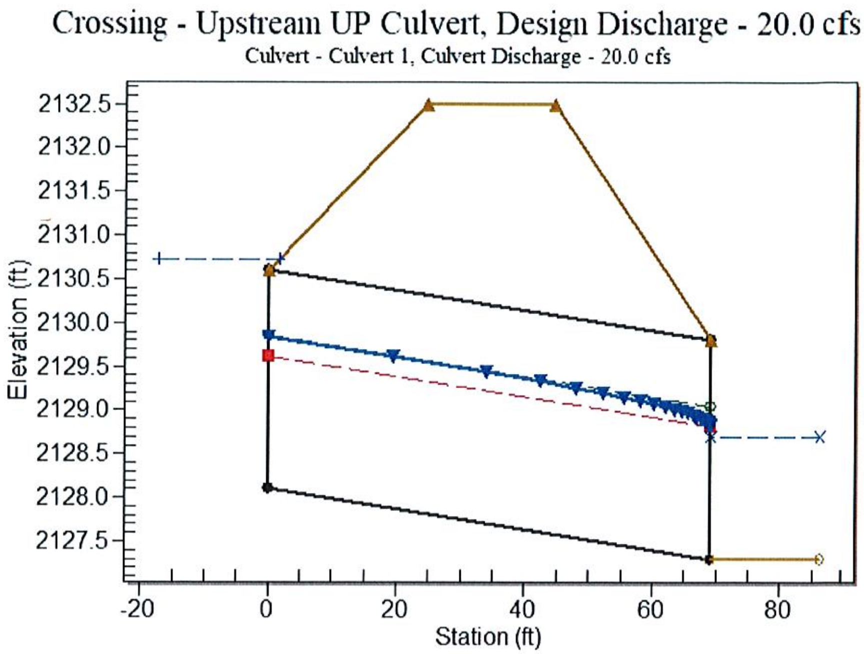
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



S

Inlet Station: 0.00 ft

Inlet Elevation: 2128.10 ft

Outlet Station: 69.25 ft

Outlet Elevation: 2127.30 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Upstream UP Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	2127.30	0.00	0.00	0.00	0.00
20.00	2128.69	1.39	2.68	0.37	0.45
40.00	2129.34	2.04	3.25	0.55	0.46
60.00	2129.84	2.54	3.62	0.68	0.47
80.00	2130.25	2.95	3.90	0.79	0.48
100.00	2130.61	3.31	4.14	0.89	0.48
120.00	2130.93	3.63	4.33	0.97	0.49
140.00	2131.22	3.92	4.51	1.05	0.49
160.00	2131.49	4.19	4.66	1.12	0.49
180.00	2131.74	4.44	4.80	1.19	0.50
200.00	2131.98	4.68	4.93	1.25	0.50

Tailwater Channel Data - Upstream UP Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 1.00 (_:1)

Channel Slope: 0.0043

Channel Manning's n: 0.0350

Channel Invert Elevation: 2127.30 ft

Roadway Data for Crossing: Upstream UP Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 2132.50 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

McGhee Subdivision
Pond Outlet Weir Design, Pipes
Hattie Zobott, P.E.

Use Plate Weir Equation
From: Chow, V.T. 1959. Open Channel Flow

Pipe to Northern Culvert-25-Year

Q	6.7	cfs	
H	1.1	ft	Head over pipe in pond
Weir	2128.4		
WSE	2129.5		
Y	1.1	ft	Height of pipe in pond
L	1.6	ft	Length of weir (circumference of pipe)
g	32.2	ft/sec^2	Gravity
Dpipe	6	in	Diameter of pipe
Cd	3.67		Discharge Coefficient
H/Y	1		Ratio of head to weir height

Pipe to Northern Culvert-25-Year

Q	12.1	cfs	
H	1.3	ft	Head over pipe in pond
Weir	2128.8		
WSE	2130.1		
Y	1.3	ft	Height of pipe in pond
L	2.1	ft	Length of weir (circumference of pipe)
g	32.2	ft/sec^2	Gravity
Dpipe	8	in	Diameter of pipe
Cd	3.67		Discharge Coefficient
H/Y	1		Ratio of head to weir height

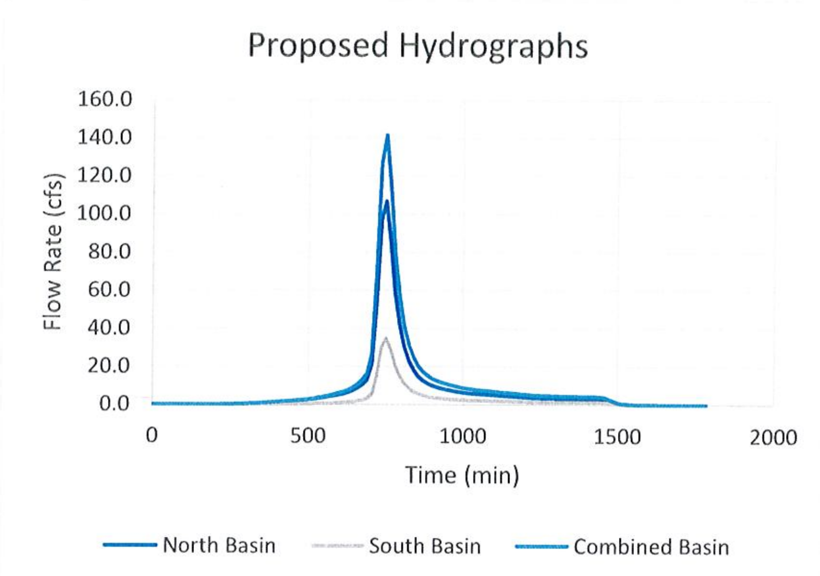
Pipe to Southern Culvert-25-Year

Q	11.5	cfs	
H	1.0	ft	Head over pipe in pond
Weir	2128.5		
WSE	2129.5		
Y	1.0	ft	Height of pipe in pond
L	3.1	ft	Length of weir (circumference of pipe)
g	32.2	ft/sec^2	Gravity
Dpipe	12	in	Diameter of pipe
Cd	3.67		Discharge Coefficient
H/Y	1		Ratio of head to weir height

Pipe to Southern Culvert-100-Year

Q	29.9	cfs	
H	1.1	ft	Head over pipe in pond
Weir	2129.0		
WSE	2130.1		
Y	1.1	ft	Height of pipe in pond
L	7.1	ft	Length of weir (circumference of pipe)
g	32.2	ft/sec^2	Gravity
Dpipe	27	in	Diameter of pipe
Cd	3.67		Discharge Coefficient
H/Y	1		Ratio of head to weir height

T-O Engineers
100-year flow



Outlet Flow	42	cfs
Total Storage Volume	301,262	cf
Total Storage Volume	6.92	acre-ft

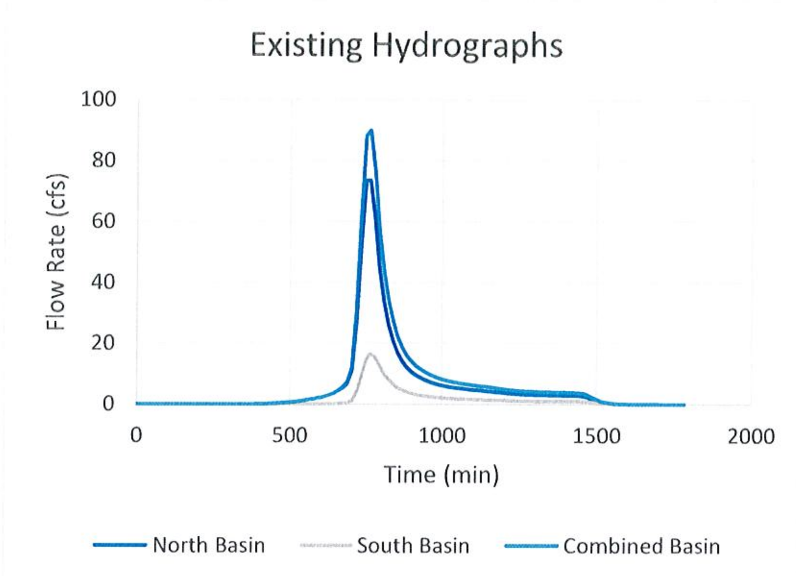
North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
0	0.0	0	0.0	0	0.0	0	
15	0.0	15	0.0	15	0.0	0	
30	0.0	30	0.0	30	0.0	0	
45	0.0	45	0.0	45	0.0	0	
60	0.0	60	0.0	60	0.0	0	
75	0.0	75	0.0	75	0.0	0	
90	0.0	90	0.0	90	0.0	0	
105	0.0	105	0.0	105	0.0	0	
120	0.0	120	0.0	120	0.0	0	
135	0.0	135	0.0	135	0.0	0	
150	0.0	150	0.0	150	0.0	0	
165	0.0	165	0.0	165	0.0	0	
180	0.0	180	0.0	180	0.0	0	
195	0.0	195	0.0	195	0.0	0	
210	0.0	210	0.0	210	0.0	0	
225	0.0	225	0.0	225	0.0	0	
240	0.0	240	0.0	240	0.0	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
255	0.1	255	0.0	255	0.1	0	
270	0.1	270	0.0	270	0.1	0	
285	0.2	285	0.0	285	0.2	0	
300	0.4	300	0.0	300	0.4	0	
315	0.5	315	0.0	315	0.5	0	
330	0.6	330	0.0	330	0.6	0	
345	0.8	345	0.0	345	0.8	0	
360	0.9	360	0.0	360	0.9	0	
375	1.1	375	0.0	375	1.1	0	
390	1.2	390	0.0	390	1.2	0	
405	1.4	405	0.0	405	1.4	0	
420	1.6	420	0.0	420	1.6	0	
435	1.7	435	0.0	435	1.8	0	
450	1.9	450	0.1	450	2.0	0	
465	2.1	465	0.1	465	2.2	0	
480	2.3	480	0.1	480	2.4	0	
495	2.4	495	0.2	495	2.6	0	
510	2.7	510	0.2	510	2.9	0	
525	3.0	525	0.3	525	3.3	0	
540	3.4	540	0.4	540	3.8	0	
555	3.8	555	0.5	555	4.3	0	
570	4.2	570	0.6	570	4.8	0	
585	4.6	585	0.7	585	5.3	0	
600	5.0	600	0.8	600	5.9	0	
615	5.6	615	1.0	615	6.6	0	
630	6.4	630	1.2	630	7.5	0	
645	7.3	645	1.5	645	8.8	0	
660	8.6	660	1.8	660	10.5	0	
675	10.4	675	2.3	675	12.7	0	
690	12.9	690	3.0	690	15.9	0	
705	21.3	705	5.4	705	26.7	0	
720	52.7	720	15.2	720	67.8	25.8	11,617
735	96.9	735	30.0	735	126.8	84.8	49,793
750	106.9	750	34.6	750	141.5	99.5	82,969
765	86.4	765	29.2	765	115.6	73.6	77,896
780	58.5	780	20.3	780	78.8	36.8	49,672
795	41.5	795	14.6	795	56.2	14.2	22,942
810	30.3	810	10.8	810	41.1	0	6,373
825	23.0	825	8.4	825	31.4	0	-
840	18.3	840	6.7	840	25.0	0	
855	15.0	855	5.6	855	20.6	0	
870	12.8	870	4.7	870	17.5	0	
885	11.2	885	4.2	885	15.4	0	
900	10.0	900	3.8	900	13.8	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
915	9.1	915	3.4	915	12.5	0	
930	8.5	930	3.2	930	11.7	0	
945	8.0	945	3.0	945	11.0	0	
960	7.5	960	2.8	960	10.3	0	
975	7.0	975	2.6	975	9.7	0	
990	6.6	990	2.5	990	9.1	0	
1005	6.3	1005	2.4	1005	8.6	0	
1020	6.0	1020	2.3	1020	8.3	0	
1035	5.8	1035	2.2	1035	8.0	0	
1050	5.6	1050	2.1	1050	7.7	0	
1065	5.4	1065	2.0	1065	7.5	0	
1080	5.3	1080	2.0	1080	7.2	0	
1095	5.1	1095	1.9	1095	7.0	0	
1110	4.9	1110	1.9	1110	6.8	0	
1125	4.8	1125	1.8	1125	6.6	0	
1140	4.6	1140	1.7	1140	6.3	0	
1155	4.4	1155	1.7	1155	6.1	0	
1170	4.3	1170	1.6	1170	5.9	0	
1185	4.1	1185	1.6	1185	5.7	0	
1200	3.9	1200	1.5	1200	5.4	0	
1215	3.8	1215	1.4	1215	5.2	0	
1230	3.6	1230	1.4	1230	5.0	0	
1245	3.5	1245	1.3	1245	4.9	0	
1260	3.5	1260	1.3	1260	4.8	0	
1275	3.4	1275	1.3	1275	4.7	0	
1290	3.4	1290	1.3	1290	4.6	0	
1305	3.3	1305	1.3	1305	4.6	0	
1320	3.3	1320	1.2	1320	4.5	0	
1335	3.2	1335	1.2	1335	4.5	0	
1350	3.2	1350	1.2	1350	4.4	0	
1365	3.2	1365	1.2	1365	4.4	0	
1380	3.1	1380	1.2	1380	4.3	0	
1395	3.1	1395	1.2	1395	4.3	0	
1410	3.1	1410	1.2	1410	4.2	0	
1425	3.0	1425	1.2	1425	4.2	0	
1440	3.0	1440	1.1	1440	4.2	0	
1455	2.8	1455	1.1	1455	3.8	0	
1470	2.1	1470	0.8	1470	2.9	0	
1485	1.3	1485	0.5	1485	1.8	0	
1500	0.7	1500	0.3	1500	1.0	0	
1515	0.4	1515	0.2	1515	0.6	0	
1530	0.2	1530	0.1	1530	0.3	0	
1545	0.1	1545	0.1	1545	0.2	0	
1560	0.1	1560	0.0	1560	0.1	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
1575	0.0	1575	0.0	1575	0.1	0	
1590	0.0	1590	0.0	1590	0.0	0	
1605	0.0	1605	0.0	1605	0.0	0	
1620	0.0	1620	0.0	1620	0.0	0	
1635	0.0	1635	0.0	1635	0.0	0	
1650	0.0	1650	0.0	1650	0.0	0	
1665	0.0	1665	0.0	1665	0.0	0	
1680	0.0	1680	0.0	1680	0.0	0	
1695	0.0	1695	0.0	1695	0.0	0	
1710	0.0	1710	0.0	1710	0.0	0	
1725	0.0	1725	0.0	1725	0.0	0	
1740	0.0	1740	0.0	1740	0.0	0	
1755	0.0	1755	0.0	1755	0.0	0	
1770	0.0	1770	0.0	1770	0.0	0	
1785	0.0	1785	0.0	1785	0.0	0	

T-O Engineers
100-year flow



Outlet Flow	42	cfs
Total Storage Volume	208,874	cf
Total Storage Volume	4.80	acre-ft

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
0	0	0	0	0	0	0	
15	0	15	0	15	0	0	
30	0.0	30	0.0	30	0.0	0	
45	0.0	45	0.0	45	0.0	0	
60	0.0	60	0.0	60	0.0	0	
75	0.0	75	0.0	75	0.0	0	
90	0.0	90	0.0	90	0.0	0	
105	0.0	105	0.0	105	0.0	0	
120	0.0	120	0.0	120	0.0	0	
135	0.0	135	0.0	135	0.0	0	
150	0.0	150	0.0	150	0.0	0	
165	0.0	165	0.0	165	0.0	0	
180	0.0	180	0.0	180	0.0	0	
195	0.0	195	0.0	195	0.0	0	
210	0.0	210	0.0	210	0.0	0	
225	0.0	225	0.0	225	0.0	0	
240	0.0	240	0.0	240	0.0	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
255	0.0	255	0.0	255	0.0	0	
270	0.0	270	0.0	270	0.0	0	
285	0.0	285	0.0	285	0.0	0	
300	0.0	300	0.0	300	0.0	0	
315	0.0	315	0.0	315	0.0	0	
330	0.0	330	0.0	330	0.0	0	
345	0.0	345	0.0	345	0.0	0	
360	0.0	360	0.0	360	0.0	0	
375	0.0	375	0.0	375	0.0	0	
390	0.0	390	0.0	390	0.0	0	
405	0.0	405	0.0	405	0.0	0	
420	0.1	420	0.0	420	0.1	0	
435	0.1	435	0.0	435	0.1	0	
450	0.2	450	0.0	450	0.2	0	
465	0.3	465	0.0	465	0.3	0	
480	0.4	480	0.0	480	0.4	0	
495	0.6	495	0	495	0.6	0	
510	0.7	510	0	510	0.7	0	
525	0.9	525	0.0	525	0.9	0	
540	1.1	540	0.0	540	1.1	0	
555	1.3	555	0.0	555	1.3	0	
570	1.6	570	0.0	570	1.6	0	
585	1.9	585	0.0	585	1.9	0	
600	2.2	600	0.0	600	2.2	0	
615	2.5	615	0.0	615	2.5	0	
630	3.0	630	0.0	630	3.0	0	
645	3.5	645	0.0	645	3.6	0	
660	4.3	660	0.1	660	4.4	0	
675	5.4	675	0.2	675	5.5	0	
690	6.8	690	0.4	690	7.2	0	
705	11.1	705	1.0	705	12.1	0	
720	26.9	720	3.7	720	30.7	0	-
735	54.1	735	8.9	735	63.0	33.0	14,861
750	73.6	750	14.4	750	88.0	58.0	40,974
765	73.5	765	16.5	765	90.0	60.0	53,118
780	61.1	780	15.5	780	76.6	46.6	47,964
795	44.7	795	12.8	795	57.5	27.5	33,340
810	33.9	810	10.0	810	43.9	13.9	18,617
825	26.3	825	8.0	825	34.3	0	6,236
840	20.8	840	6.6	840	27.4	0	
855	16.9	855	5.4	855	22.3	0	
870	14.1	870	4.6	870	18.7	0	
885	12.0	885	4.0	885	16.0	0	
900	10.6	900	3.5	900	14.0	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
915	9.5	915	3.1	915	12.6	0	
930	8.7	930	2.8	930	11.5	0	
945	8.0	945	2.6	945	10.6	0	
960	7.3	960	2.4	960	9.8	0	
975	6.8	975	2.3	975	9.1	0	
990	6.421	990	2.103	990	8.524	0	
1005	6.067	1005	1.98	1005	8.047	0	
1020	5.8	1020	1.9	1020	7.7	0	
1035	5.5	1035	1.8	1035	7.3	0	
1050	5.3	1050	1.7	1050	7.1	0	
1065	5.2	1065	1.7	1065	6.8	0	
1080	5.0	1080	1.6	1080	6.6	0	
1095	4.8	1095	1.6	1095	6.4	0	
1110	4.7	1110	1.5	1110	6.2	0	
1125	4.5	1125	1.5	1125	6.0	0	
1140	4.4	1140	1.4	1140	5.8	0	
1155	4.2	1155	1.4	1155	5.6	0	
1170	4.1	1170	1.3	1170	5.4	0	
1185	3.9	1185	1.3	1185	5.2	0	
1200	3.8	1200	1.2	1200	5.0	0	
1215	3.6	1215	1.2	1215	4.8	0	
1230	3.5	1230	1.2	1230	4.6	0	
1245	3.4	1245	1.1	1245	4.5	0	
1260	3.3	1260	1.1	1260	4.4	0	
1275	3.2	1275	1.1	1275	4.3	0	
1290	3.2	1290	1.0	1290	4.2	0	
1305	3.1	1305	1.0	1305	4.1	0	
1320	3.1	1320	1.0	1320	4.1	0	
1335	3.0	1335	1.0	1335	4.0	0	
1350	3.0	1350	1.0	1350	4.0	0	
1365	3.0	1365	1.0	1365	4.0	0	
1380	2.9	1380	1.0	1380	3.9	0	
1395	2.9	1395	1.0	1395	3.9	0	
1410	2.9	1410	1.0	1410	3.8	0	
1425	2.9	1425	0.9	1425	3.8	0	
1440	2.8	1440	0.9	1440	3.8	0	
1455	2.7	1455	0.9	1455	3.6	0	
1470	2.3	1470	0.8	1470	3.1	0	
1485	1.706	1485	0.636	1485	2.342	0	
1500	1.127	1500	0.456	1500	1.583	0	
1515	0.7	1515	0.3	1515	1.0	0	
1530	0.4	1530	0.2	1530	0.6	0	
1545	0.3	1545	0.1	1545	0.4	0	
1560	0.2	1560	0.1	1560	0.2	0	

North Basin		South Basin		Combined Basin		Storage Needed	
Time	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Time (min)	Flow Rate (cfs)	Excess Flow (cfs)	Volume (cf)
1575	0.1	1575	0.1	1575	0.2	0	
1590	0.1	1590	0.0	1590	0.1	0	
1605	0.0	1605	0.0	1605	0.1	0	
1620	0.0	1620	0.0	1620	0.0	0	
1635	0.0	1635	0.0	1635	0.0	0	
1650	0.0	1650	0.0	1650	0.0	0	
1665	0.0	1665	0.0	1665	0.0	0	
1680	0.0	1680	0.0	1680	0.0	0	
1695	0.0	1695	0.0	1695	0.0	0	
1710	0.0	1710	0.0	1710	0.0	0	
1725	0.0	1725	0.0	1725	0.0	0	
1740	0.0	1740	0.0	1740	0.0	0	
1755	0.0	1755	0.0	1755	0.0	0	
1770	0.0	1770	0.0	1770	0.0	0	
1785	0.0	1785	0.0	1785	0.0	0	