HONEY LAKE VALLEY RESOURCE CONSERVATION DISTRICT

INFRASTRUCTURE INVENTORY AND CAPITAL IMPROVEMENTS PLAN
LASSEN COUNTY, CALIFORNIA
JANUARY 2013

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Honey Lake Valley Resource Conservation District (RCD) has commissioned a study regarding the infrastructure inventory and potential capital improvements for infrastructure in the Susan River Basin. The RCD and the Natural Resource Conservation Service (NRCS) helped to provide initial data on 236 structures to be inventoried and analyzed in this study. During the study, structures were added to the inventory as needed. The list of structures inventoried is extensive; however, it is not all inclusive. The structures were evaluated through a ranking matrix to determine top priority structures to the watershed and irrigation districts. Due to budgetary constraints, this study does not cover all potential improvements to the existing system, instead this is a study to highlight the most critical structures and define a critical path for the implementation of improvements to maintain use, improve conveyance, and lessen the threat of catastrophic flooding. Therefore, of the 236 structures, the top 20% (47 in total) were evaluated beyond the initial evaluation criteria and analyzed for future improvements.

1.2 PURPOSE

The purpose of this study is to evaluate and assess the existing infrastructure that comprises the RCD system as well as other infrastructure that directly affects the flows and water usage in the Susan River Basin. This study will include a summary identifying critical structures and provide recommendations on courses of action in order to improve the system as a whole and maximize the use of available resources. The final report will be a critical solution in recapturing and reusing water that is currently lost through the antiquated hydrologic conveyance system.

1.3 BACKGROUND & HISTORY OF HONEY LAKE VALLEY IRRIGATION SYSTEMS

Honey Lake Valley irrigation refers to a system that shows evidence of being in existence since the 1850s. The current system has been in place since the 1930s and was finalized in the 1940s in *Fleming vs. Bennett* which established *The Susan River Decree*. Surface water irrigation in the lower Susan River Watershed is managed mainly by two main entities, the Honey Lake Valley Resource Conservation District (HLVRCD) and the Lassen Irrigation Company (LIC). LIC delivers stored irrigation water to the non-riparian agricultural users while HLVRCD handles riparian water users, generally parcels adjacent to a natural water course. Water rights were set forth in the *Susan River Decree* and are tied to property. The individual users are tasked with the maintenance of their turnouts but are managed and overseen by water masters for HLVRCD and LIC. Irrigation for both of these systems is accomplished through a system of dams in the main channel of the Susan River and larger tributaries that redirect flow into a network of sloughs, ditches, and canals for farm use.

The LIC contains a network of approximately 31 miles of canals, sloughs, and ditches that rely on stored water from three major reservoirs. The Susan River begins as two channels draining Caribou Lake and Silver Lake in western Lassen County. The first reservoir utilized is McCoy Flat Reservoir where storm water is stored and then released into the Susan River. Hog Flat Reservoir is an offline reservoir that serves the same purpose on the other reach of the Susan River. From here, flows are released into the Susan River where they flow toward Susanville. At the Johnsonville Dam, flows are split from the Susan River into the Leavitt Lake, the third storage reservoir controlled by the LIC.

HLVRCD is charged with governing five main bodies of water. The Susan River, Willow Creek, Gold Run Creek, Paiute Creek, and Lassen Creek all provide conveyance and storage for the riparian water ways. This system eventually terminates into Honey Lake, but in dry years, the flow is reduced to nearly nothing.

While the two systems are used for irrigation, the problems and infrastructure that beset them are different. A large portion of the existing infrastructure consists of LIC's channels and ditches which are unlined, manmade structures that lose an estimated 50-60% of their water through infiltration and evaporation while the structures on the Susan River and other waterways of HVLRCD are exhibiting signs of failure, undercutting, and leakage, which contribute to lost flows during the summer, inability to accurately measure water flows, and difficulty in water flow controls.

1.4 STUDY METHODOLOGY

System structures were ranked using a comparative matrix that weighted various details of structures against other structures in the system. The variables and details ranked on the structures related to location, use, and functionality. In addition, an on-site analysis of the system was completed with the help of Jeff White and John Richards, representatives of HLVRCD and LIC respectively, who have expansive knowledge of the system. Through discussions with the HLVRCD board and others, onsite inspections, information provided by the NRCS, public input, and historical reports that were found regarding the system, DEC was able to rank the structures in the system and identify 47 structures for further analysis.

1.5 REPORT FINDINGS

The structures identified as most critical to the basic function of the system were structures found mainly on the Susan River. From a conservation and improved system management standpoint, dams and measurement structures are ranked the highest. For an increase in available flows through conservation, LIC's conveyance system was identified as having the largest water losses.

From an ecological impact, Hog and McCoy flats were identified as areas needing further study.

As a result of the study three areas of importance surfaced as paramount for system improvements in the future:

- Water Management
- Water Conservation
- Flood Control

These three action items all work together to make a more efficient system. Separately they also address the key concerns for both irrigation districts; availability of water. Below is an analysis of these findings as they apply to the top 17 structures as identified in Table 1.

Name	Independent Ranking Score	Structure Type	Estimated Cost*
Charpontier Dam	30	Measurement/Diversion	$186,000.00
Johnstonville Dam	29	Measurement/Diversion	$950,000.00
100 Inch Weir	28	Measurement/Diversion	$54,000.00
Gold Run Diversion	27	Measurement/Diversion	$87,000.00
Bridge Creek Into McCoy Flat Reservoir	25	Measurement	$9,000.00
Ramsey's Diversion Ditch	25	Measurement/Diversion	$18,000.00
Mill Diversion	25	Dam	$15,000.00
Lassen Street Measuring Device	25	Measurement	$34,000.00
Toscani Dam	25	Measurement/Diversion	$750,000.00
Window Dam	25	Measurement/Diversion	$83,000.00
Colony Dam	24	Measurement/Diversion	$1,000,000.00**
Susan River into McCoy Flat Reservoir	22	Measurement	$32,000.00
McCoy Flat Reservoir Emergency Overflow	22	Spillway	$750,000.00
McCoy Flat Reservoir Outlet into Susan River	21	Measurement	$59,000.00
Hog Flat Parshall	21	Measurement	$59,000.00
Buffum Parshall	21	Measurement	$71,000.00
Virgil's Parshall	21	Measurement	$55,000.00

Table 1: Top Ranked Structures with Engineers Estimate

* Costs have been roughly estimated and rounded to the nearest $1,000, no preliminary engineering design has been performed.

** Costs is quite variable, depending on the desired goal of the dam. If the dam is to be returned to original height and volume the costs could increase significantly.

1.5.1 **Water Management**

Currently both HLVRCD and LIC employ deputy water masters to manage the waters of the system. The key concern for both districts is the ability to manage the system. From Caribou Lake down to Mahle Diversion, existing structures are lacking in measurement devices, ease of operation, leaking, or are failing.

The measurement flumes on the reservoirs are undersized (inlet to McCoy), degrading (outlet of McCoy) or failing (Hog Flat). Without accurate measurement capabilities, reporting available water or understanding flood conditions is not possible. The reservoirs can be better managed for longer storage periods, better releases to compensate for inflows, and potential storage expansion. Flows leaving the upper reservoirs are divided into two categories, LIC and RCD water. These flows are distinguished by flow measurements taken above McCoy Flat Reservoir and measurements taken at the outlets of said reservoirs.

Johnstonville Dam is also a dam of high concern given the nature of flows experienced. During the high water event of 2011, the deck of the Johnstonville Dam was moved 6 inches by the hydrostatic forces present on the uprights and flashboards. This dam is not safely managed in high water situations given the design of the uprights and the 15 feet of head against the flashboards. In every emergency situation, flashboards and in some cases uprights are blown out to try and relieve pressure on the dam. The restoration of this dam would allow for the capture of flood waters for irrigation use rather than losing them to Honey Lake.

Other dams in the system, such as Window Dam and Colony Dam are non functional (Window) or missing (Colony) and currently have little or no beneficial purpose. Colony Dam's measurement structures leak and are in bad repair. Colony Dam is integral in determining when water can be taken from the Susan River and stored in Lake Leavitt as well as historically storing water within the river channel.

Overall, the existing structures highlighted within this text do not function at a high level necessary for ease of management. All the structures analyzed within this text have the recommendation to be outfitted with supervisory control and data acquisition (SCADA) units. Remote management allows for real time data as well as access to areas traditionally blocked off due to snow and storm events. Publically available data will help plan for irrigation scheduling as well as recreation activities such as fishing and boating/floating the river. By having flow data available starting at the head waters then down to below Johnstonville Dam, informed flow distribution and flood water management decisions can be made. For example yearly flows exceed 1,000 cfs above Johnstonville Dam, but only 250 cfs can be safely conveyed through the AB canal with the majority of the flows going unused or to Honey Lake because accurate and real time data across the entire irrigation system is not available. Instantaneous data collection will increase the water masters ability to anticipate and manage high flows in the upper watershed by opening dams and removing obstructions in the lower watershed to provide high water flows a beneficial use outlet or increased storage waters.

1.5.2 **Water Conservation**

Seepage in conveyance canals, losses through measuring devices and defunct structures all lead to a decrease in useable water supply. The United States Bureau of Reclamation (USBR), estimates that a leaking structure can contribute as much as a 1% loss in available water, which in aggregate with the large number of structures in the system results in a significant loss.

Seepage in unlined canals within LIC's system is responsible for losses approaching 60% annually. From LIC's water master, supplied flows in 2011 were 40,000 Ac-ft while delivered flows were 16,000 Ac-ft. Delivery losses were calculated from the outflow of Lake Leavitt then measured as delivered on farm flows. Using pan evaporation rates from USGS, losses approaching 12,000 Ac-ft per annum are realized across the reservoirs. Combining delivered losses and evapotranspiration, losses of almost 37,000 Ac-ft per annum were calculated for the 2011 irrigation season.

LIC's conveyance system was built mostly on the remains of Lake Lahontan. This consists of sandy beds and minimal clay deposits. Seepage is controlled by permeability at measured rates through saturated soils; leading to the constant known as Ksat. These soils lead to Ksat rates ranging from 0.14 in/hr to soils with seepage rates exceeding 100 in/hr. Calculations performed using seepage rates and canal lengths show seepage losses approaching 24,000 Ac-Ft per year, mirroring losses reported by John Richards and other LIC members. The losses in the system would provide 2.5 additional fillings of Lake Leavitt at current capacity. If these flows could not be delivered to LIC users, water would be readily available for reservoir storage and in most years, river flows. Through improving the LIC distribution system using pipes or lined canals, a potential 24,000 additional Ac-ft per year could be realized by the entire system.

Historical data revealed that Lake Leavitt was designed with a capacity of 12,100 Ac-ft when constructed. In 2008 capacity curves were generated by the NRCS and a total capacity of 9,338 Ac-Ft was calculated. Hog Flat rarely fills to capacity being an offline reservoir and McCoy Flat's capacity is assumed. Sedimentation has been an issue since presented by the State Soil Conservancy in 1967, and has not been addressed since then. Additionally, leaking at both McCoy and Hog Flat Reservoirs have been reported for years and should be substantiated. Increasing the capacity of Lake Leavitt and evaluating McCoy and Hog Flat capacities could potentially allow the system to be restored to the originally 31,500 Ac-ft of storage as adjudicated in *The Susan River Decree.* Increased capacity allows for better capture of flood events as well as a prolonged irrigation season.

1.5.3 Flood Control

Flooding in the system has been reported as a biennial occurrence with historical river flows from 1900 - 1997 supporting a 5 year cycle. Flooding often damages existing structures, causes bank and channel erosion, and can damage crops. While flooding cannot be predicted, it can be better managed through proper flood control planning and design. Currently, neither the Johnstonville Dam nor the AB Canal is sized to handle high flood flows.

There is no river storage existing below Johnstonville Dam. Historical records show Colony and Window Dam provide an additional volume of storage. High waters cause down cutting in the channel, riparian degradation, and lead to the spread of white top and other noxious organisms.

Flooding causes hundreds of thousands of dollars in measureable damage to fields, structures and equipment in the Susan River watershed. Flooding, being unpredictable in nature, can also cause great harm to the ecosystem through the spreading of fertilizers and herbicides that are stored in outbuildings or areas believed to be immune to a reasonable flood plain. By implementing changes that correct and better manage floods, risks to the economy, roads, and fields are greatly reduced while captured flows increase.

The structures of the system, when restored to full functionality will increase the ease in which the system is managed and enable increased conservation. Remote measurement and the addition of actuators to some structures attached to the SCADA system will allow for remote management of the system as well as both saving and increasing the available water supply. Should LIC retrofit their existing system, the net benefit to the entire watershed would be a substantial increase in flows for all users. By capturing flood flows, HLVRCD and LIC will show an increase in deliverable flows, improve the lifespan of their structures, and save money on an annual basis in basic water master services and costs.

1.6 RECOMMENDATIONS

The final recommendations found in this report are reflective of public comment and review performed by citizens of Lassen County and members of the HLVRCD board. Public opinion and comment were solicited in September 2012 and incorporated into this study December 2012 with final revisions in January 2013.

From the analysis performed on the system, water conservation through flood management, loss reduction, and creating a manageable system through infrastructure improvement will result in an increase in the useable water supply. Flood management can be better performed by installing measurement devices at key points on the river, such as inflow and outflow of McCoy Flat Reservoir, rehabilitating old dams such as Johnstonville, and replacing structures that have surpassed their useful lifespan such as Colony Dam. Better flow measurement will result in flood forewarnings allowing the water masters to better move water to places of storage, use, and result in lower losses.

Water loss reduction can be achieved by replacing leaking structures and lining the LIC conveyance system at a minimum. Piping LIC's system will reduce seepage rates to a negligible level as well as limit evapotranspiration rates as measured in the canals. A piped system will also encourage sprinklered systems by the end users which will further increase the on farm and total system efficiencies.

Implementing the above changes creates a system that can be monitored by the water masters both remotely and more accurately in field. Flows will be better controlled and monitored in all weather situations and should lead to an increase in water delivered to the end users. The primary concern should be water management through measurability and flood management.

2.0 DESCRIPTION OF THE HLVRCD

2.1 LOCATION - GEOGRAPHICAL AREA

The Honey Lake Valley is located within the Susan River Area near Susanville California. The ecosystem is comprised of 748,875 acres of agricultural use, range, and forest, exclusively in Lassen County. The watershed originates in the Cascade Range, at which the Susan River begins at 7,000 feet of elevation and drains, 40 miles later, into Honey Lake at approximately 4,000 feet above sea level. The Susan River has six major tributaries that drain the watershed, Paiute Creek, Gold Run Creek, Lassen Creek, Willard Creek, Cheney Creek, and Willow Creek, as well as numerous seasonal streams and creeks located within the watershed. The annual precipitation of the basin ranges from 7 - 30+ inches a year, with the majority of that coming in the winter months in the form of snow. The majority of the basin receives less than 18 inches of precipitation throughout the year, providing a semi-arid environment with an abundance of sun, a wide range of temperature, and rapid evaporation. 90% of the total precipitation occurs between October 1st and May 31st, during the non-irrigation season.

Geographically, the Susan River Watershed is very diverse. The Honey Lake Valley is bounded by the Basin and Range Province to the east, the granitic Sierra Nevada Range to the southwest, and the volcanic of the Modoc Plateau and the Cascade Range to the north and west. The Susan River Watershed ranges in elevation from 7000 feet above sea level at the headwaters and 4000 feet in the Honey Lake Valley on the east end of the project.

2.2 MANAGEMENT AND OPERATIONS

Board of Directors:

Robert Anton:	Chairman
Jeff Pudlicki:	Vice-Chair & Watershed Rep.
John Bentley:	Treasurer & SWAT Rep.
Dave Schroeder:	Director & WAC Rep.
Larry Cabodi:	Director & Sage Grouse Rep.
Barbara Howe:	Alternate Director
John Richards:	Alternate Director

Staff, Operating Personnel

Watermaster Advisor Committee (WAC):

Jeff Hunphill:	Chairman & Farm Bureau Representative
Darin Hagata:	Vice Chair/Willow Creek Representative
Dennis Cooly:	Lower Susan River Representative
John Mallery:	Upper Susan River Representative
John Richards:	Lassen Irrigation District Representative
Jeff Hemphill:	Baxter Creek Representative
Larry Cabodi:	HLV RCD Representative
Watershed Coordinator:	Tim Keesey
Water Master:	Jeff White

The HLVRCD is a conservation district that provides oversight and guidance within the Honey Lake Valley. The Honey Lake Valley RCD is currently involved in a number of soil conservation, water conservation, water distribution, flood control, erosion control, erosion prevention, or erosion stabilization project, within or adjacent to the Honey Lake Valley district. These include sage grouse range management, water master services, Timber and Meadow, and the Lassen County Special Weed Action Team (SWAT).

2.3 EXISTING REPORTS AND DATA

There is a significant amount of existing data that was reviewed in the preparation of this report. The following reports were utilized in this infrastructure improvement study and are referenced throughout the document:

- *Water SMART: System Optimization Review Application*, Lassen Irrigation Company
- *Susan River Watershed Management Strategy*, Susan Watershed Group
- *Susan River Area Rapid Watershed Assessment*, NRCS
- *Misc. Flood Reports 1965, 1967, 1995, 1997*, NRCS
- *Susan River Decree (1940 primarily with other decrees as well)*

3.0 WATER RIGHTS

3.1 WATER RIGHTS OWNERSHIP

The water rights were formalized in 1940 with *The Susan River Decree* and include all properties that are serviced by the current HLVRCD and LIC. While LIC users are a customer of HLVRCD, they are serviced by their own entity due to the nature of their water shares and how they were historically procured. The total irrigable land, as set forth by *The Susan River Decree*, as administered by both HLVRCD and LIC is 30,916.8 acres. This land is broken down into 6 sections of the decree. The first section enumerates all the land owners and acreages to be irrigated. Section 2 delineates the locations of the approved diversions and structures. Sections 3-5 outlines the water rights adjudicated to Willow Creek, Gold Run Creek, Lassen Creek, Piute Creek, Susan River, and their tributaries. These rights are broken down into first, second, and third priorities which dictate amount of water allotted as well as which rights are subservient rights to others. Schedule 6 outlines special water rights such as LIC's and Sierra Pacific's ownership. The equivalent continuous flows total 309.59 cfs. These adjudicated rights can be found in *The Susan River Decree.*

The water rights of this system are dividing into two categories, riparian and non-riparian. The non-riparian water rights are administered by the LIC and are stored within the three reservoirs on the system. They are provided to the individual parcels through the canals, ditches, and structures located therein. These two systems administer the flows that provide the majority of the irrigation needs for agriculture and range lands, with the remainder being provided by individual ground water wells. Updated lists of current water rights owners are held by the water masters of HLVRCD or LIC. Historical ownership adjudications and maps are provided in **Appendix E**.

3.2 DEMAND

Current irrigation demands vary from year to year depending on individual crop selection and quality of winter water (i.e. snow pack and late spring rains). From NRCS and Bureau of Reclamation tables, average agricultural demands range from ½ to 1½ acre feet per acre planted for wheat and barley up to 3-4 acre feet per acre feet planted for the primary crops of the region of pasture, perennial hay and alfalfa. Taking the average demand of 2.25 acre feet per acre for all the irrigated land as laid out in the *Susan River Decree*, the annual demand was calculated to be 69,562 Ac-ft per annum. This number was only used for modeling and estimating purposes. Future studies should determine actual demands and adjust the findings presented herein accordingly. Critical acreage was determined by NRCS and was defined as agricultural and livestock users who relied on ground water pumping to finish their growing season. This lowers the water table and brings salty ground water to the surface, degrading both crops and surface water sources. Within the watershed, there are approximately 20,000 critical acres that rely on water from the two irrigation providers. Their average demand is calculated as 45,000 Ac-ft per annum.

4.0 DESCRIPTION OF WATER SYSTEM

4.1 EXISTING INFRASTRUCTURE

4.1.1 Overview

The existing water system is controlled by two different entities broken down into smaller sections. LIC controls the canals and irrigation water that services non-riparian lots while HLVRCD services the riparian lots, generally located in close proximity to a body of water. The LIC system can be broken down from the reservoirs into a series of canals, ditches, and individual head gates that comprise the entire district. These systems will be analyzed beginning with the individual reservoirs and work down to the end users. The HLVRCD system will be broken into five sections that cover the main bodies of managed water; Susan River, Willow Creek, Paiute Creek, Gold Run Creek, and Lassen Creek. Other creeks, such as

4.1.2 Dams and Reservoirs

HLVRCD and LIC water begins at the head waters of the Susan River in Caribou and Silver Lake, as two separate channels. The Susan River flowing from Caribou and Silver Lakes is dammed at McCoy Flat Reservoir. The next major inflow into the Susan River comes from Hog Flat Reservoir, which is an offline reservoir that captures a small portion of the watershed. The capacity of these two reservoirs was historically 22,112 Acre-ft. From these reservoirs, the Susan River flows towards Susanville for approximately 17 miles. As the Susan River flows into the more gradually sloped valley it broadens and flows with an incised channel before meeting with the Johnstonville Dam. Johnstonville Dam diverts water from the Susan River into Leavitt Lake. These three storage reservoirs provide approximately 31,500 Acre-ft of storage and are broken down by historical capacity in Table 1.

LIC Storage Reservoirs	
Reservoir	Estimated Capacity (Ac-ft)
Hog Flat Reservoir	6,400
McCoy Flat Reservoir	13,000
Leavitt Lake	12,100

Table 1: Storage Reservoir Capacity

Current capacities for Hog Flat and McCoy flat are not known, Leavitt Lake had capacity curves generated in 2008 and was determined to store 12,100 Ac-ft. LIC estimates their current capacity for storage in all 3 reservoirs to be approximately 31,500 Ac-ft.

4.1.3 Primary Irrigation Structures

Primary irrigation structures are those that are located on the Susan River, creeks, sloughs, and ditches. These are considered primary structures because of the volume of water that they control, divert, and measure. These structures are generally dams, weirs, and measuring devices. Because they are located at outfalls and within the channel, they are of a higher importance and a larger impact on the end users of the system. A list of primary structures surveyed can be found in **Appendix A**.

4.1.4 Secondary Irrigation Structures

Secondary Structures are structures that are located on individual ranches and farms and generally consist of head gates and measuring devices. These structures are secondary due to the nature of their use. These structures generally only serve one parcel and do not undergo high flows or volumes when compared to the other structures. They are located along the canals, creeks and Susan River but not within the channel of these conveyance means. A list of these structures can be found in **Appendix A**.

4.1.5 Canals

From Leavitt Lake, flows are directed to the individual parcels through a series of gravity fed canals, ditches, and some piping. Within this system, there are approximately 256 structures that help to regulate and measure the flow. An extensive list of structures for the watershed can be found in **Appendix A**. For the purposes of this report, the watershed will be divided into two sections, upper and lower. The upper section consists of the headwaters down to Johnstonville Dam and the lower section shall be from Johnstonville Dam to Honey Lake. 186 of these structures are located in the lower watershed and serve to divert flows to both irrigation districts. These are a wide variety of structures that include gates, dams, weirs, and flumes for flow measurement and control. The breakdown of these structures is found in Table 2. Not all structures were inventoried by the NRCS when they completed the Rapid Watershed Assessment in December of 2011.

Structure Type	LIC	HLVRCD
Dam	6	14
Diversion	9	17
Head gate	75	17
Weir	27	12
Pump	9	3
Other	0	7
Totals:	126	60

Table 2: Analyzed Structures

Each of these structures was inventoried and then listed by the primary problem noted. Secondary problems were also noted during the survey with approximately 30% of the structures exhibiting erosion or weed overgrowth. In Table 3, the problems are compiled for both of the irrigation districts. About 20% of the structures inventoried in the lower basin did not have any problems nor need corrective action.

Primary Problem	LIC	HLVRCD
No Problem	17	21
Limited Functionality	68	24
Undercutting/Failure Potential	3	2
Lacks Measuring Device	4	5
Leakage	33	5
Channel Work Needed	2	5
Totals:	126	60

Table 3: Structure Concerns

For both of the irrigation districts, the primary problem is a lack of functionality. The majority of the structures that were surveyed with problems are head gates meant to divert and distribute the flows from the canals to the fields. These headgates are leaking, diverting too much or too little, or are exhibiting other forms of failure resulting in water waste throughout the irrigation season. It is estimated by the Bureau of Reclamation that losses through structures can range from 5%-20% of total flows.

The majority of the structures are located on the canals and ditches that compromise the LIC system. These canals and ditches are used to convey water from the Susan River and Lake Leavitt into the LIC system. Their network is listed in Table 4.

Flows in the canals are controlled by the LIC and are provided on an as-needed basis.

Condition	Length (miles)
Untreated Conveyance Canal	16.3
Untreated Ditch	9.3
Lined Open Ditch	3.9
Piped	0.25
Totals:	29.75

Table 4: Canal Conditions

The majority of the canals are untreated and built on native material. Within this basin, soil Ksat values range from a moderately low value of 0.014-.14 inches/hour to a very high of 14-100 inches per hour of infiltration. All of LIC's ditches and canals are constructed on soils that have Ksat values above 0.14 inches per hour. The conveyance canals are listed in Table 5 by percentage over the soil Ksat on which they overlie.

Ksat Class	Ksat (inches/hour)	Percent of Ditch Underlain by Ksat Class
Moderately High	0.14 - 1.4	61%
High	1.4-14.1	34%
Very High	14.1 +	5%

Table 5: Soil Ksat Rates

5.0 INFRASTRUCTURE ASSESSMENT

5.1 CONDITION ASSESSMENT

In the HLVRCD and LIC, 234 structures were assessed and ranked. In order to do this in a uniform manner, a ranking matrix was created to rate each structure in the following 8 categories:

- Conveyance Type
- Function
- Primary Problem
- Secondary Problem
- Date Constructed
- Use
- Condition of Structure
- Independent Ranking Assessment

Each of these categories was assigned a score from 1-5, with 1 being the lowest score and priority, and five being the highest. The categories were all given equal weight, with the exception of the problem characterization, which was doubled in the ranking process. This was done so that conveyance type would not have an exaggerated value in the ranking, as the majority of the structures exist on smaller conveyance systems such as ditches and headgates. The Ranking Matrix can be found in **Appendix A**.

The conveyance type is broken down into Susan River, Creeks, Canals, Ditches, and Headgates. Headgates are considered to be all opening from a main channel into a parcel for irrigation or livestock purposes.

The function of these structures was broken down, in ascending score, 1-5, into 5 categories: Measure, Divert, Measure and Divert, Impound, Impound and Divert, with measure being a score of 1 and impound and divert being a score of 5. Measuring of flow is a critical function for all irrigation districts, but has the least amount of impact for the end users of the system, while the failure of a dam or weir in the system would result in the largest potential for negative impact for the end users of the irrigation district.

Primary and Secondary problems were gleaned from the *NRCS Rapid Watershed Assessment* that was completed in 2011. These problems were identified and broken into 5 categories: None, Maintain, Repair, Leaking/Undercutting, and High Failure Potential. Scoring was kept 1 - 5 for uniformity, but in the summation column, it was given a weighted value of 2. Secondary problems were given scores of 1 for no problems, 2 for invasive weeds, and 3 for channel rehab, generally meaning regrading or reshaping of the channel.

Date constructed was given a uniform score of 2 throughout the project. It is an important factor as most concrete structures only have a lifespan of 50. While many structures evaluated had dates stamped on them from the 1950s, uniform information was not available for all of the structures at the time of this study, so all structures were given the same arbitrary score of “2”. The column was left in the matrix though for future studies or if construction data was ever found for the entirety of the project.

Use was broken into two scores, 1 and 3. A score of 1 was assigned if the irrigation application was recreation and a value of 3 was assigned for agriculture and ranching uses. Agriculture and Ranching were assigned a higher value as they are the foundation of the local economy within the Honey Lake Valley watershed. Additionally, environmental and recreational enhancements will be a byproduct of improved agriculture and ranching water usage.

An independent ranking assessment was tasked to the LIC as well as the HLVRCD water masters, Dennis Cooly and Jeff White respectively. They were asked to rank the existing structures in their own opinion and knowledge to provide a working knowledge of the system as well as years of management to the study. Through their independent analysis, a move complete engineering analyses was performed, ensuring that key structures and conveyance systems were not missed due to washout or scope of project.

The Data Ranking Matrix was employed to rank the structures and identify potential candidates for replacement and upgrades. This matrix was only applied to the existing structures within the HLVRCD and LIC irrigation districts. The complete Irrigation Ranking Matrix can be found in **Appendix A.** The canals, ditches, and sloughs were analyzed independently and under a different system as a matrix was not the most efficient means available.

5.2 STRUCTURES ASSESSMENT

The existing structures and majority of the system was initially field evaluated better gauge the condition of the system as well as a means to validate the ranking matrix that was applied to the system. From this ranking, the top 40 structures were selected through a ranking process as well as through input from the water masters of both HLVRCD and LIC. The structures chosen for evaluation were based on their impact to the system, location within the watershed, as well as the purpose of the structure, with a higher importance given to structures that were essential for flow control and measurement. Through this process, the below structures were individually analyzed with additional onsite inspections:

Name	
Charpontier Dam	Toscani, Div 53
Gold Run Creek	Willow Creek - DFG
Toscani Dam	Willow Creek DFG
100 in. Weir	Diversion #75
Old Channel Weir	Diversion #78
Gold Run, Diversion 187	Susan into McCoy
Lassen Creek	Willow Creek, Miller
Deep Cut Dam	McCoy Dam - Release Gate
Gold Run	Buffum Dam
Gold Run, Richmond Rd	Hog Flat Parshall
Mill Diversion	Diversion 56
Ramsey Ditch Head Gate	Mahle Diversion
Window Dam	Virgil's Parshall
Woodstock Dam	McCoy Outlet
Whirley Creek	Bridge Creek
Colony Dam	Diversion #2
Johnstonville Dam	Buffum Parshall
Old Channel Headgate	Hog Flat Outlet
Toscani, Div 51-52	Hog Flat Dam

Table 6: Evaluated Structures

Of the structures analyzed, the top 17 are further analyzed below, these 17 structures are critical for capital improvements planning These structures were chosen for in-depth analysis as they were found to be detrimental to the system in both structural deficiencies and lack of functionality. These structures were chosen for immediate action as their failure would prove catastrophic to the entire watershed and water users of both the HLVRCD and LIC irrigation districts. These structures were not given a ranking of importance at this point as they are all critical to the overall function of the system. Any improvements undertaken will be a positive impact on the system.

Name	Independent Ranking Score	Structure Type
Charpontier Dam	30	Measurement/Diversion
Johnstonville Dam	29	Measurement/Diversion
100 Inch Weir	28	Measurement/Diversion
Gold Run Diversion	27	Measurement/Diversion
Bridge Creek Into McCoy Flat Reservoir	25	Measurement
Ramsey's Diversion Ditch	25	Measurement/Diversion
Mill Diversion	25	Dam
Lassen Street Measuring Device	25	Measurement
Toscani Dam	25	Measurement/Diversion
Window Dam	25	Measurement/Diversion
Colony Dam	24	Measurement/Diversion
Susan River into McCoy Flat Reservoir	22	Measurement
McCoy Flat Reservoir Emergency Overflow	22	Spillway
McCoy Flat Reservoir Outlet into Susan River	21	Measurement
Hog Flat Parshall	21	Measurement
Buffum Parshall	21	Measurement
Virgil's Parshall	21	Measurement

Table 7: Top Ranked Structures

5.2.1 Caribou Lake Outlet, Caribou Lake Spillways, and Diversion 2-5

The Honey Lake Valley Resource Conservation District continues to work with the Roney Cattle Company to design and repair structures at Caribou Lake and Diversions #2-5 in order to improve the ability to accurately measure water diversions at these locations. The Roney Cattle company, at the request of the Water Master, has purchased a head gate and measuring device for Caribou Lake that have not yet been installed. The infrastructure improvements for these structures will be published in a separate report developed by the RCD in conjunction with Roney Cattle Co.

5.2.2 Susan River into McCoy Flat Reservoir

The Existing inlet to McCoy Flat Reservoir is a broad, shallow channel covered with volcanic rock that is funneled into an 8 foot Parshall flume with a concrete apron and a rock lined spillway that drops approximately 2 feet from the apron to the flow line. A stilling well is located within the Parshall flume for flow measurement and recording. The existing channel upstream of the flume is ill-defined and has many areas where flows circumvent the flume in high flow events and spring runoff. At the structure, side cutting, undercutting of the apron and concrete degradation are all evident. The concrete is showing signs of cracking, scaling, and failure in the apron itself. The flume is undersized, is not level, and the ramp appears to have sagging within the channel itself, rendering accurate flow measurement impossible. Submergence during spring runoff (flows that exceed 139.5 cfs) is a common event while flows less than 3.5 cfs cannot be recorded due to the limiting nature of Parshall flumes. The upstream wing walls are undersized and lead to flows missing the flume as well as side cutting and leakage around and through the structure. The approach ramp of the flume as well as the wing walls show signs of undercutting and erosion, as well as freeze-thaw damage. Overtopping does not appear to be a problem at this time.

The improvements to this structure are two-fold. The first improvement is to demolish the existing structure and replace it with a broad crested weir with a low flow channel. The broad crested weir will have an increased length of 12 feet which will increase the current measurement capacity from 139.5 cfs to approximately 215 cfs. Additionally, it is recommended that a larger apron be poured on both the inlet and outlet sides of the weir. A stilling basin with pressure sensors should be installed and connected to a radio SCADA unit for remote measurement. The outlet side of the weir should be ramped down to the existing channel bottom with energy dissipaters installed to reduce erosion. Wing walls should extend at least 30 feet from either side of the inlet in order to better capture flows from the Susan River Channel. A cutoff wall of at least 4 feet should be poured under the weir to limit seepage and undercutting.

The second improvement is channel rehabilitation. Due to the nature of high flows, river water is split approximately 100 feet above the existing structure into three channels. Two of the channels join together 20 feet in front of the existing flume, but the third channel circumvents the entire structure, flows through an adjacent meadow, and then into the reservoir. For better flow measurement, this third channel should be blocked using a dike with engineered soil to provide an embankment that will keep the flows within the Susan River channel. The engineer's estimate for this project is $32,000. Channel rehabilitation costs were not analyzed at this time.

Figure 1: Susan River into McCoy Flat Reservoir

5.2.3 McCoy Flat Reservoir Emergency Overflow

The emergency overflow for McCoy Flat Reservoir is a buttress dam using flash boards to maintain water levels. The structure is in poor condition exhibiting numerous problems. Around the dam itself, boils are evident, leaking through the flash boards, exposed aggregate, scaling, and freeze thaw failure. Seepage and side cutting is also evident. A significant amount of flow is being realized through seepage loss. Additionally, on the face of the dam, concrete is shearing off and exposing rebar. There is evidence of past repair, specifically re-coating the structure with a thin layer of concrete, now falling away from the dam. Large cracks can be found in both the buttresses and the wing walls of the structure. During high flows, flash boards are manually pulled from the dam, often times remaining in place due to hydrostatic forces. Due to this, flood management is almost non-existent as water pressure makes it impossible to manage flood events. There are reports of leaking through the dam when the water level exceeds 10 feet of depth, but could not be substantiated due to low water levels.

The emergency overflow dam should be entirely replaced due to the condition of the existing concrete. A new cutoff wall should be installed, extended to at least 15 feet in depth to match the maximum water level at the overflow. This increased cutoff wall should reduce seepage as well as boils that are currently forming on the outflow side of the dam. Pressure transducers should be installed on the reservoir side and connected to a radio SCADA unit for remote depth measurement. For flood control, radial gates connected to the SCADA system are recommended. This will allow for complete flood control from a remote location. The preliminary cost to replace this dam would be approximately $750,000, which is subject to change pending future hydrologic and geotechnical studies.

Figure 2: McCoy Flat Reservoir Overflow

5.2.4 McCoy Flat Reservoir Outlet into Susan River

Flows out of McCoy Flat Reservoir are measured in a 12 foot Parshall flume. The flume appears to have been built in 1954 from a date stamped into one of the wing walls. While flows can be measured fairly accurately, this flume has settled over the years on the eastern side resulting in an uneven throat. Additionally, the concrete of the flume is cracked, scaled, and showing signs of freeze-thaw failure with exposed aggregate present throughout. Rebar has been exposed in the throat and diverging section. The upstream wing walls are undersized and as a result, side cutting and seepage is occurring throughout the structure. There does not appear to be any evidence of submergence or overtopping of the bank at this structure.

This structure should be replaced with a new 12 foot Parshall flume. The new structure should have enlarged wing walls on both the upstream and downstream side, extending the wing walls an additional 10 feet should limit the side cutting, while a small cut off wall should be installed on the upstream ramp to prevent seepage under the new structure. The existing stilling well should be retrofitted to accept a SCADA radio system to allow remote monitoring for better flood management and dam management. The engineer's estimate for this project is $59,000.

Figure 3: McCoy Flat Outlet 12' Parshall Flume

5.2.5 Bridge Creek into McCoy Flat Reservoir

Bridge Creek is a perennial seep fed stream that flows into McCoy Flat Reservoir and is a secondary source of surface water utilized for storage. There is an existing USGS gauge station that appears to have been abandoned having been washed out in past high water events. For water reporting and planning purposes, it is important to measure flows into McCoy Flat Reservoir. The recommended action is to install a 9 inch steel Parshall flume. Flow measurement will be recorded in a stilling basin fitted with pressure transducers connected to a radio controlled SCADA unit for remote monitoring. The engineer's estimate for this project is $9,000.

Figure 4: Bridge Creek

5.2.6 Hog Flat Parshall

The existing flow measurement at Hog Flat Reservoir is an 8 foot steel Parshall. The measurement structure is undersized, bent, and not level. When originally constructed, the steel stabilizing bars were not installed in the structure resulting in the soil pressure collapsing the top of the throat walls. The existing wing walls are corrugated steel pilings that are no longer flush with the structure allowing for side cutting and flows escaping the converging section. The existing structure was also set at an elevation that was too low, resulting in submergence in moderate flows rendering the functionality of the structure obsolete. The flows released from Hog Flat Reservoir exceed the capacity of the current structure during high release events. To correct these problems, it is recommended that a new 10 foot concrete Parshall flume be installed in the current location. Concrete wing walls shall be installed on all four corners extending an additional 15 feet to facilitate flow capture and limit side cutting of the bank. Limited grading is expected due to the existing topography immediately adjacent to the structure. A stilling basin fitted with pressure transducers connected to a radio SCADA unit should be installed to allow for remote measurement and data collection. The cost to replace the existing steel structure with a poured in place concrete Parshall will be approximately $59,000 dollars.

Figure 5: Parshall Flume at Hog Flat Reservoir

5.2.7 100 Inch Weir

The 100 Inch Weir is used to split flows from Willow Creek for stock watering and agricultural use as well as water measurement for the Department of Fish and Game. Willow Creek is diverted upstream into a canal for a short run before being returned to its natural channel through the weir. The current structure is a concrete weir with slots for flash boards for flow control. Flow is measured over the tops of the boards manually by the water master. The current orientation of weir and flashboards first then a spillway make flow measurement difficult in high water flows. The concrete is cracked, scaling, with large pieces missing from the head and wing walls resulting in exposed rebar. Erosion is evident on the creek side of the structure from high flows and an absence of wing walls. The engineer's recommendation calls for the replacement of the structure as well as the addition of wing walls on the downstream channel section. The new structure shall reverse the orientation of the weir and apron as well to facilitate flow measurement. Flash boards shall still be used due to the varied nature of flows and quality of water rights. To facilitate management, a locking system shall be installed as well so the water master can set flow limits. A monitoring well fitted with pressure sensors shall be added to the new structure and connected to a radio SCADA unit for remote flow monitoring. The engineer's estimate for this project is $54,000.

Figure 6: 100 Inch Weir on Willow Creek

5.2.8 Ramsey's Diversion and Ditch

Ramsey's diversion and ditch diversion is a low-head, sand bag diversion and water conveyance ditch located adjacent to Hobo Camp on the Susan River. This diversion is used to convey water from the Susan River into the Ramsey's ditch for on river water users. The existing diversion is approximately 30 feet of sandbags and a small channel dredged to a CMP outfitted with trash screen and head gate that provide flows into Ramsey's ditch. The current head gate structure is bent, and the concrete is cracked, exposed aggregate, and scaling. The required flows amount to 5 cfs during peak demand, but only 3 cfs is currently being delivered. This flow schedule was obtained through empirical evidence and data as existing flow measurement is not possible at this location. The engineer's recommendation includes replacing the existing damaged gate and concrete structure with a new head wall and a new 24 inch by 24 inch head gate. The channel from the river to the ditch should be slightly enlarged to accommodate more flows. Downstream of the new head gate, an existing 12 inch concrete Parshall flume shall be retrofitted with a stilling basin outfitted with pressure transducers and connected to a radio controlled SCADA unit for remote flow measurement. The new gate shall be provided with flow rating curves to facilitate flow delivery. Ramsey's Diversion is a critical project for flow measurement, because this is the first diversion down-stream of the reservoirs and the first place where water is taken from the Susan River for individual use. The engineer's estimate for this project is $18,000.

Figure 7: Ramsey's Ditch Intake

5.2.9 Mill Diversion

The Mill Diversion is a buttress dam that was previously used for diverting water to the mill pond and lumber yard owned and operated by Sierra Pacific Power Company. The current structure has been removed from service and no longer serves as a beneficial use structure. There are plans to create a white water park through the City of Susanville that require the removal of this structure and regrading of the river channel and bank. This structure has collapsed sections, leaking gates, exposed rebar, and failing concrete. In the current condition, this structure is a safety hazard and should be removed. Removal of this structure should be done in conjunction with construction of the white water park, as the existing channel has a large drop (approximately 6 feet) that will need to be re-graded to prevent further down cutting and erosion. The cost to only remove the structure would be approximately $15,000. Channel rehab and preparation for a white water park are costs that could not be analyzed at this time.

Figure 8: Mill Diversion

5.2.10 **Lassen Street Measuring Device**

The Susan River first enters into Susanville at Lassen Creek Road. At this crossing, there is a bridge with a rated section used to estimate river flows. This is the first measurement device on the Susan River downstream of Hog and McCoy Flat Reservoir. Currently, the bridge abutments serve as the rated section while a stilling well and staff gage are used to record flows. Under the bridge, the channel is of natural construction. Natural stream beds are not conducive for flow measurement as they are not a uniform section and change frequently in form. This was evident during the site visit in which debris was observed under the bridge being caught and held in place by boulders and other obstacles sitting on the channel bottom. The existing wing walls are properly sized for this structure as limited side cutting evidence was found during field investigations. To remedy this, a concrete apron 30 feet wide by 50 feet long and 6 inches in depth shall be poured between the existing concrete bridge supports. The existing stilling well shall be retrofitted with pressure transducers and a radio connected SCADA unit for remote monitoring. This structure is critical for flood control in Susanville as it serves as the first river measurement device downstream of Hog and McCoy Flat Reservoirs. Measuring flow during storm events at this point on the river will allow for better reservoir management, and better downstream management of gates and dams. The estimate cost to pour a concrete bottom within the bridge supports and retrofit the stilling basin with SCADA units is $34,000.00.

Figure 9: Susan River at Lassen Creek Street Bridge

5.2.11 Johnstonville Dam

Johnstonville Dam is located on the Susan River and is one of two measurement devices that dictate when water can be diverted from the Susan River into the LIC system. Flows above 200 cfs are directed into the AB canal which flows to Leavitt Lake for LIC storage and distribution. The dam is a buttress dam with wooden uprights with a steel deck created from a repurposed rail car. Water levels are controlled through the placement of flashboards on the wooden uprights. Flows are measured by manually reading a staff gage affixed to one of the dam buttresses. This dam is critical for flood control as it directs flows to Leavitt Lake, stores flow within the river channel, and can be used to manage peak flows from various sub watersheds within the Susan River watershed. Critical design flaws were identified by DEC during site visits in June of 2012. In high flow situations, water pressure does not allow for pulling of flash boards. To manage high flows, the water master connects a rope to an upright, floats the rope downstream for retrieval, loops the rope around a telephone pole for leverage, then attaches the rope to a hitch on his truck. The truck is then backed up until the bottom of an upright can be pulled away from the dam. This results in a loss of flash boards, a large rush of water through a narrow orifice, and a dangerous situation for the water master. The current capacity of the system is approximately 400 cfs. While flows exceeding 200 cfs can be put into the AB canal, as well as an emergency overflow canal on the opposite side of the dam, the max flow deemed “safe” by the water masters is approximately 420 cfs. Spring runoff routinely exceeds 500 cfs, with flows as large as 700 cfs occurring on a 10 year interval. During the spring runoff of 2011, water pressure moved the bridge deck 6 inches before flows were released by using the above method. The loss of this bridge would be one of the largest detriments to the system for both RCD and LIC water users as it is used to control and distribute river and reservoir flows to the various water users.

The existing structure is in ill repair. The end support structures are cracked and pitted while the middle buttress has a large piece missing at the point of connection with the deck, exposing a lack of rebar. There was no evidence of side cutting along the wing walls, but there are boils downstream of the structure proving that undercutting of the dam is an issue. The existing flashboards are old, many of them cracked and leaking profusely at the bottom of the dam. DEC recommends that this dam be replaced in its entirety. The proposed dam would be a buttress style dam with radial gates installed in lieu of flashboards and uprights. A stilling well with pressure transducers should be installed and coupled with a radio SCADA unit. The radial gates should be actuated and controlled with the same SCADA unit. Changing this dam to a bottom opening structure will require a larger spillway with energy dissipaters but will provide better flood control and a safer working environment for the water masters. Remote access will allow for dam management in large events when overtopping of the dam is a possibility, as has happened in flood events in the 1980s and 1990s as reported by the NRCS. The preliminary cost to replace this dam would be approximately $950,000, which is subject to change pending future hydrologic and geotechnical analysis.

Figure 10: Johnstonville Dam

5.2.12 **Buffum Parshall**

Buffum Parshall is located on the AB canal just upstream from Leavitt Lake. Buffum is used to measure flows in the canal prior to entering Leavitt Lake. This Parshall flume is an 8 foot style flume. The structure is in good repair but three deficiencies were identified by DEC during field investigations. First, the flume is set too low within the channel resulting in submergence during high flows. Parshall flumes of this size can only handle a max flow of 139.5 cfs before submergence corrections need to be applied. The max flow of the AB canal is 200 cfs. While there are two upstream water users, their rights do not draw 60 cfs from the canal. Coupled with the flow line being set too low in the channel, Buffum is regularly rendered unusable due to higher flows. The second issue with Buffum Parshall is bank and channel stability. The AB canal has been subject to years of down cutting and the current structure sits approximately 15 feet below the channel top, with nearly vertical side slopes that continually erode into the channel. The third deficiency found on the flume is the flow measurement device has not been calibrated to read correctly. To rectify this problem, DEC recommends a rebuild of the Parshall flume coupled with laying back the streams banks at a 3:1 slope. The new flume shall be a 12 foot flume, capable of handling flows of 350 cfs before submergence. The flume shall be installed with a stilling well outfitted with pressure transducers which will be connected to a radio SCADA unit allowing for remote measurement. The banks extending 50 feet upstream and 50 feet downstream shall be laid back at a 3:1 slope and then reinforced with rock rip rap. This will prevent further erosion and sloughing into the canal. The engineers estimate to complete this project is $71,000.

Figure 11: Buffum Parshall

5.2.13 **Toscani Dam**

Toscani Dam is located on the Susan River and is the boundary of Schedule 5 priority 2 flows. Thus, flows at this structure are used to determine downstream water appropriations. The existing dam is comprised of two upright concrete structures on which a 40 foot by 12 foot rail car bed is laid. The uprights are driven into the channel bottom and rest against this rail car. Flashboards are used to control the flow and concrete wing walls direct flows to a 36 inch CMP culvert. During field analysis, concrete flaws were observed on the dam as well as other flow problems. The concrete of the wing walls and end buttresses was in fair condition. Boils around the end of the concrete apron and as far away as 20 feet from the dam face were recorded by DEC. Leaking around the wing walls and through the flashboards was noted. No flow measurement was currently observed at this structure. DEC recommends that this dam be retrofitted with a new cutoff wall extended deeper into the substrate, buttresses poured within the channel fitted with radial gates, and flow measurement added. Radial gates are recommended because of the volume of water stored within this section and as a means to effectively manage high water flows during storm and spring runoff events. The radial gates can also be rated for flow for ease of management. The dam shall be installed with a stilling well outfitted with pressure transducers which will be connected to a radio SCADA unit allowing for remote measurement. The radial gates can also be actuated for remote management if so desired. Without actuating the radial gates, the Engineers estimate for this project is $750,000 which is subject to change pending future hydrologic and geotechnical analysis.

Figure 12: Toscani Dam

5.2.14 **Colony Dam**

Colony Dam is located at the confluence of Willow Creek and the Susan River. This structure historically had been used as a means to store water (up to 600 acre feet) as well as a measurement of river and creek flows. This is a critical structure for both RCD and LIC for water management. Per *The Susan River Decree,* when flows in the Susan River exceeded 20 cfs during the period of March 1 to July 1 and when in excess of 5 cfs at all other times, water could be diverted into Leavitt Lake at Johnstonville Dam for storage purposes. The existing structure is two 8 foot Parshall flumes, one on each channel, and a concrete dike that separates the Susan River from Willow Creek. The original dam is no longer functioning, as the bridge deck, uprights, and center buttress are not present; it is believed to have washed out during flooding periods. The existing flumes are both showing signs of scaling, exposed rebar, cracked concrete, and sever leakage along the wing walls, head walls, and within the Parshall itself. Boils are evident along the entire length of both flumes with large volumes of backwater present on both flume faces. During high flows, the Parshall flume on the Susan River submerges from being undersized. Additionally, the concrete dike is leaking in multiple locations, allowing the comingling of river and creek flows above the measurement devices. Three actions are recommended by DEC for these existing structures. First, the concrete dike shall be restored to prevent leaking and seepage. The dike shall be retrofitted with new concrete and the cut off wall shall be expanded to limit leakage and seepage. The existing Parshall flumes shall be retrofitted with new concrete. The Susan River Parshall flume shall be enlarged to a 10 foot Parshall flume to handle higher flows during flooding events. Both flumes shall be outfitted with radio SCADA units to allow for remote monitoring and measurement by the RCD water master. Colony Dam itself was originally incorporated into the flume structures and utilized a staff gauge during high water to measure flows. During low water periods, the uprights were removed and the flumes were used for water measurement. The nature of this construction was to store flows in both the Willow Creek and Susan River Channels. By doing so, accurate flow measurement of the Susan River for diversion purposes was not possible. Additionally, combining the flows for storage did not allow for Willow Creek measurement during water storage periods. Colony Dam shall be relocated approximately 50 feet upstream of the current location. Doing this will allow for measurement of Willow Creek during water storing periods as well as no longer comingling of river and creek flows. Moving the dam upstream will create more permitting needs but will result in a simpler design. By keeping the dam in its current location, results in an increase in dike size to keep flows separate and measurable. The current location results in a span about twice as wide as moving the dam upstream to be located solely in the Susan River Channel. Also, Reinstalling Colony Dam will render the Parshall flume downstream redundant. DEC recommends keeping the measurement flumes in the same location though due to ease of access and manual measurement for the water master. Additionally, by replacing the existing Parshall flumes, Susan River water management will not be reliant on Colony Dam being reconstructed.

Should HLVRCD and LIC chose to reconstruct Colony Dam the primary benefit would be an increase in river storage and management of flood conditions, resulting in an approximate addition of 600 Ac-ft of water storage; dependent of future hydrologic and channel analysis. The cost to rehabilitate the Colony Dam Parshalls and dike will be approximately $179,000. The cost to rehabilitate the Colony Dam will be approximately $500,000 to $1,200,000 depending on whether or not the dam was use for storage again and returned to original height (like it was originally intended), but shall be subject to change following further hydraulic and geotechnical analysis and verification of channel capacity.

Figure 13: Colony Dam Parshalls

5.2.15 Charpontier Dam

Charpontier dam on the Susan River is a diversion structure that divides flows into Dill Slough and what is known as Tanner Slough (Susan River). This dam is basically a broad crested weir with two low flow channels that can be closed with flash boards. The dam spans the Susan River channel. The dam itself was most recently repaired in the 1980s through the addition of new concrete. During the site visit, many structural problems were observed. The original structure appears to have been a stone and mortar build with successive concrete layers added throughout the years. The mortar and concrete are both cracked, there are missing stones in the structure, and the broad crested weir is leaking in numerous spots at its base. Boils were observed on the high water apron in numerous locations. Holes within the spillway were observed and side cutting was noted on the south western wing wall. DEC recommends that Charpontier Dam be restored to prior condition by replacing the existing structure. A new dam should be poured in the same location with wing walls extended further upstream. A larger cut off wall should be installed to reduce seepage and boils that are currently present. Instead of having two windows, a low flow channel shall be built and with the ability to place flashboards to control flow into Dill Slough. This low flow channel and addition of flashboards shall be rated for flow measurement. The weir portion of the dam should be uniformly poured and rated to provide useable flow measurement. A stilling basin with pressure transducers shall be installed with a radio SCADA unit for remote flow recording. The estimated cost to reconstruct Charpontier Dam is $186,000, but shall be subject to change following further hydraulic and geotechnical analysis and verification of channel capacity.

Figure 14: Charpontier Dam

5.2.16 Window Dam

Window Dam is located downstream of Charpontier Dam on Dill Slough and was used as a means to store water within the slough's channel. The dam is a single span with a bottom opening "window". Historically, flash boards were used to control the river level. Water was intended to flow over the flashboards and in low flows and flushing situations, through the orifice at the bottom of the dam. This orifice was controlled by attaching a chain to a pneumatic device located on the south bank, over a pulley, then attached to a piece of plywood covering the opening. This required the water master to walk across the top of the flash boards and hook the “shutter”. The pneumatic device has been nonfunctional for years now and the dam is no longer operable as originally intended. Therefore, water is no longer stored within this section of Dill Slough; at this point as the orifice remains opened. During field evaluations, the condition of the structure was analyzed and was determined to be in ill repair. The concrete on the wing walls exhibits significant cracking that is leading to movement between the two sections. The dam face was observed to have lateral stress fractures across the surface showing significant strain caused by uncontrolled flows. The uprights for flashboards are old pipes that have been shorn off to allow for access to the top of the dam and far bank. No concrete apron was present leading to erosion and undercutting of the dam during high flow events through the orifice and over the dam top. No flow measurement was present during the site visit. DEC recommends rebuilding the dam. New concrete shall be poured for the entire structure. The “window” should be replaced with dual weir gates. An apron poured of concrete should be poured in the spillway with appropriately sized energy dissipaters added at the end to reduce undercutting from dam flows. River flows should be recorded with a stilling basin outfitted with pressure transducers and connected to a radio SCADA unit for remote monitoring. Actuators could be added to the sluice gates to allow for remote management as well, but due to an increase in cost, and a non-necessary addition, this shall be left to the discretion of the irrigation district. Flows should no longer be managed in such a manner that overtopping of the dam is permissible. Providing storage at this structure would help better manage Susan River flooding events as high waters could be diverted at Charpontier Dam and stored at Window Dam for future use. The cost to rehabilitate Window Dam is $83,000, but shall be subject to change following further hydraulic and geotechnical analysis and verification of channel capacity.

Figure 15: Window Dam

5.2.17 Virgil's Parshall

Virgil's Parshall is an 8 foot throated flow measuring device located on Dill Slough downstream of Window Dam. This is the first flow measurement device located on Dill Slough. The existing structure was deemed to be in moderate condition with minimal concrete damage observed. The device itself though was labeled as "unusable" by the water master during DEC's site work. Virgil's Parshall has settled within the slough and sits too low for most flow conditions. Total submergence during spring flows is consistently observed and standard flows generally exceed the normal depth range associated with an 8 foot throated Parshall. Accurate flow measurement is only available at the end of the irrigation season when flows are low enough to not need adjustment tables. DEC recommends replacing the existing structure with a new 10 foot Parshall for an increase in flow capabilities with care being taken to set the invert elevation higher in the channel to prevent excessive depths and submergence during high flow conditions. The flume shall be installed with a stilling well outfitted with pressure transducers which will be connected to a radio SCADA unit allowing for remote measurement. The engineers estimate to complete this project is $55,000.

Figure 16: Virgil's Parshall

5.2.18 Gold Run Diversion

Gold Run Diversion is a dam located on Gold Run Creek that diverts water into a side channel for agricultural use. The condition of this dam is imminent failure. It is the opinion of DEC that this dam will fail in a high water event if not managed properly. This is the first diversion located on Gold Run Creek. The existing dam is a concrete structure outfitted with wooden uprights and flashboards for flow control. No flow measurement was present at the time of DEC's site assessment. From the upper creek bed, water flows experience two drops, the upper being a concrete apron and the lower drop is a rock lined channel. Concrete wing walls extend from the structure at an inadequate distance to prevent side cutting. From field analysis, the existing structure was found to be in critical condition. The north-western down-stream wing wall has separated at the joint and is held in place by the 8 rebar tensioning rods. The uprights rest on an old log. Boils were present downstream of the dam. The first drop, the concrete apron, was eroded away exposing the rebar mesh. Flows have eroded under the apron causing undercutting and stability issues. Debris has been used to back up flows into the diversion channel; flashboards having been washed away in prior storms were not replaced. The side buttresses are cracked diagonally throughout both structures, causing mild separation in these walls. Hydrostatic and earth soil pressures have caused the entire structure to shift forward and lean over the existing creek. Soil erosion from high water flows and side cutting have exposed the foundation of the structure. DEC recommends that this structure be completely restored. New buttresses and wing walls shall be poured in place. The two drops shall be concrete with an exposed cut off wall poured between the two drops to prevent back cutting. The uprights shall be replaced with sluice gates for flow control to remove the need for flash boards. Actuators could be added to the sluice gates to allow for remote management as well, but due to an increase in cost, and a non-necessary addition, this shall be left to the discretion of the irrigation district. The dam shall be installed with a stilling well outfitted with pressure transducers which will be connected to a radio SCADA unit allowing for remote measurement. The engineers estimate to complete this project is $87,000.

Figure 17: Gold Run Diversion

5.3 Canal Assessment

The existing canal network that provides irrigation water from Leavitt Lake and distributes it to individual parcels is managed by LIC. This network contains approximately 30 miles of gravity fed systems comprised of unlined open channels, lined channels, and a small amount of pipe. The main problem that the LIC has encountered is seepage losses with a smaller set of losses coming from leakage. Additionally, many of the measurement devices within the system need repair or total replacement. In speaking with Dennis Cooly, it was determined that seepage is accountable for at least 50% of the losses in the system. In the 2011 irrigation season (150 days), LIC released approximately 41,000 Ac-ft from Leavitt Lake, but only delivered 16,000 Ac-ft to end users. That represents a loss of 25,000 Ac-ft, or 60.97% of all waters diverted. Diversion losses and evaporation losses were analyzed but not included in the report as they generally account for less than 1% of the total losses in a system.

To calculate a seepage loss rate, a modified Darcy's equation was used. The formula employed was Q = Ksat*A*H where:
Q = Flow
Ksat = Saturated Hydraulic Conductivity
A = Area of the canal
H = Hydraulic Gradient.

A range of Ksat values were provided through the RWA and are shown in Table 5. For each of the untreated soil conditions, the lowest Ksat for a given condition was applied; therefore rates of 0.77, 6.15, and 14.10 inches/hour were applied. For the lined canals, a Ksat of 0.05 inches/hour was used based on studies performed by the Bureau of Reclamation. For the piped section, the Ksat was 0.007 inches/hour. In order to obtain the hydraulic gradient, NRCS web soil survey was used to map three distinct Areas of Interest (AOI) from Leavitt Lake down to Honey Lake. These 3 areas encompass approximately 20,000 acres and cover the majority of the canal system. Using the soil data within these AOI's was then averaged using a weighted method based on soil type within the area. These three maps can be found in **Appendix D**. From this, an average H value of 4.19 feet was calculated. This was not performed for the Ksat values as the range in values was too large to get an accurate value for modeling purposes. Finally, an average wetted perimeter of 1 foot was assumed for the canals, effectively making the total area 1 foot times the total length. This area was assumed due to the fluctuating nature of flows as well as the smaller size of ditches and sloughs that compromise the majority of the system as well as a reduced infiltration rate through the sides of the canal. Although the ditches may be larger in size, a bottom width times the length of the channel was felt to be a more reflective pattern of infiltration rather than trying to model infiltration through the sides of the canals and ditches. This area was also applied to the piped system as the size of the pipe is currently unknown.

The existing canal data was broken down into four categories as shown in Table 4 and analyzed as such. There is a total of 25.6 miles of untreated canal, 3.9 miles of lined ditch, and 0.25 miles of piped irrigation flow. These distances were used in calculating the total area of infiltration. The total calculated seepage loss was broken down into both cubic feet per day and Ac-ft per year. LIC is experiencing seepage loss at a rate of about 7 million cubic feet per day, or 24,400 Ac-ft per year. While this number is less than the total given to Dyer engineering by 600 Ac-ft per year, it is a calculated error of only 2.4% which is within the excepted standard deviation of error. To further increase the flows to match up with existing field data, an increase in Ksat could be achieved by individually analyzing the soils that underlie the canals. It is probable that some sealing of the canals has occurred over the years due to sedimentation and vegetation decay. This information can be obtained by doing extensive testing of the existing channel beds and is not deemed to be necessary at this time. The most likely explanation is losses due to diversion structures. This number would equate to approximately 1.5% of the total flows released by LIC during the irrigation season. The calculations used to analyze this system can be found in **Appendix B.**

5.4 RECOMMENDED CAPITAL IMPROVEMENTS

The system evaluation resulted in the identification of two specific improvements, one for each district that would provide the largest improvement potential. Within the HLVRCD, eighteen structures were identified that need restoration that would improve the existing system, with an additional two primarily serving LIC being identified as well. These structures were found to be critical by the ranking matrix as well as through discussions with the HLVRCD board. By replacing the listed structures, flows would be better impounded, diverted, and measured. Additionally, improved structures would allow for better management of flood waters, allowing for more water to end users, increases in stored water potential, and a measurable system. Many of the structures found critical to the well being of HLVRCD's system are shared with LIC, but as they are located within HLVRCD managed waters, they are solely attributed to them.

For the LIC, the recommended capital improvement is the replacement of the canals, ditches, and sloughs with a piped network. The existing conveyance network experiences seepage losses approaching 60% of total flows put into the system. Due to the underlying soils and the unlined channels, seepage loss rates are extremely high. The recommended solution is to pipe the entire system. If this were done, the seepage losses would be reduced from 25,000 Ac-ft per year to 52.85 Ac-ft per year. This is a reduction in losses of 99.7%. With the additional 25,000 Ac-ft stored in Lake Leavitt, the LIC could potentially provide irrigation services for the remainder of the grow season which would allow for the growth of new crops for the next growing season or improved crop rotation. Due to storage limitations, if LIC were unable to provide the additional water savings to their users, the water would remain within the Susan River which would increase deliverable flows to HLVRCD users as well as Honey Lake and DFG resources. The engineers estimate to put this system into pipe was calculated using rough values and preliminary analysis as a detailed analysis was beyond the scope of this project. The estimated cost is $12,820,000. Piping would be the preferred method as plastic pipe has the longest life span and the greatest reduction in seepage losses. Additionally, by providing a pressurized system, farms requiring irrigation could be compelled to update their systems to a sprinklered system from flood irrigation. This upgrade would improve on farm efficiency from a low end of 58% to a low end range of 63%, which is an increase of 5% to the available water.

The channels could be plastic lined as well, which would result in a total seepage loss of 374.26 Ac-ft which is a reduction of 98.4%. Concrete lined channels are effective for larger canals, but on the smaller ditches and sloughs, it would not be economically feasible, and after three years of service, seepage protection is diminished from 0.05 in/hr to 0.24 in/hr due to freeze thaw cycles. Lining the channels is not the preferred improvement as it still subjects the canals to evaporation losses (minor) and promotes flood irrigation, which is the least efficient means for irrigation fields. Additionally, membrane lining has a useable lifespan of only 20 years. Cost was not analyzed for this option as there was not enough existing data on canal dimensions to accurately develop a price. This could be accomplished through cross section and hydraulic analysis, both of which were beyond the scope of this study.

6.0 COST ESTIMATES

6.1 DAMS

The dams located within this system were all evaluated based on existing size of structure and replacing with a similar sized structure. Many of the structures were anecdotally known as being undersized or placed incorrectly. The scope of this project was to identify areas of improvement and recommend corrective actions. This limited scope did not allow for in depth analysis required in dam sizing and cost estimating, including soil analysis, hydrologic flow and loading, or survey. These estimates were generated to a confidence level of plus or minus 20%. Should a structure be selected for immediate action, a more concrete cost would be established during the engineering and design portion of the selected project. The evaluated dams preliminary costs are outlined in **Appendix C**.

6.2 FLOW MEASUREMENT STRUCTURES

The flow measurement structures costs were based on current bid tabulations and a preliminary site analysis. All cost estimates are generated to a confidence level of plus or minus 20%. Refined cost estimates will be generated with further analysis including soils conditions, hydrologic studies, and more accurate survey data. **Appendix C** outlines the cost for the analyzed flow measurement devices covered within this report.

6.3 CONVEYANCE

The cost for piping the entire LIC system was computed by assuming an annual equivalent max flow of 36.65 cfs as determined by *The Susan River Decree*. This is an assumed flow based on the decree and does not reflect adjudicated rights or distribution. The above flow was only utilized in pipe sizing and cost estimating. Future hydrologic analysis as well as user demand should be performed to garner a more accurate cost to implement this recommendation. The main line would be a 30 inch water pipe running a total length of 7.33 miles. The remainder of the pipe, (24.16 miles), would be sized at 12 and 8 inches, divided evenly throughout the system. Head requirements are low, as are friction losses in this example. Three pumps would be installed to provide cycling and redundancy, and to extend the life of the pump station. The preliminary cost is $11,367,100 with the break down shown in **Appendix C.**

7.0 WATER CONSERVATION

7.1 OVERVIEW AND CURRENT EFFORTS

Water conservation is a priority action within the Honey Lake Valley watershed. Riparian zones, wetlands, water quality and quantity, fish habitat, and efficient usage were identified as management concerns by the HLVRCD. Another key concern to the watershed is the spread of invasive weeds, especially perennial pepperweed (*lepidium latifolium*). Rangeland health and floodplain management are important to community as they are the foundation of the local economy. Within the basin, there are two endangered species, the Modoc Sucker and the Carson Wandering Skipper, a threatened Slender Orcutt Grass, and five candidates for listing: Pacific Fisher, California Wolverine, Webber's Ivesia, Black Rock Potentilla, and the Greater Sage Grouse. The water resources are crucial to the protection and propagation of these species within the basin. The parties that are in charge of the management of the resources within the basin can be found in the NRCS Rapid Watershed Assessment completed in 2011.

The concerns that can be remedied through the improvement of the HLVRCD and LIC irrigation networks are erosion, water usage, and fisheries. Currently, the irrigation systems experience erosion and down cutting due to the nature of the soils and the condition of the canals, as well as the yearly removal of water from the Susan River and surrounding creeks. Coupled with the frequent flooding that occurs on about a 10 year interval due to levees and canal structures, about 70% of the existing channels were deemed "non-functional", meaning that the hydrologic, vegetative, and/or geologic components of the system are not operating in a manner that facilitates a healthy riparian system as a whole. The effects of ongoing human caused disturbances on overall stream corridor health appear greatest in the middle and lower reaches of the Lower Susan River sub-watershed.

The Susan River watershed currently supports both warm and cold water fisheries, albeit in small numbers. Fishery health is an issue during summer months when water levels in the reservoirs become precipitously low. Botulism is a major concern for ducks located in Lake Leavitt and the USFS spends a week every year moving water fowl from Hog Flat Reservoir to McCoy Flat Reservoir.

Currently, there are efforts being made by private action groups as well as local agencies such as HLVRCD and SWAT to eradicate weeds, improve aspen groves, and restore the environment to a natural ecosystem. The formation of this group came about because of concerns regarding irrigation water and invasive weeds. The Susan River Watershed Group was formed in 2009 to meld these two separate issues concerning the community into one committee.

7.2 FLOOD CONTROL

The Susan River watershed is subject to flooding on a consistent basis. From documents written in the 1960s to present day flood data, significant flooding can be expected on a 3-5 year interval. Significant flooding is any high water event that causes river water to leave the channel at any point and spread across the floodplain. The most recent documented flood available to DEC (1997), river water overtopped the bridge at 395 and caused damage to the shoulder and surrounding properties. The existing bridge was not sized to handle a 50 year storm event and subsequently was inundated. A peak flow of 5,000 cfs was realized and jumped the Susan River bank in multiple locations. The damage to one property owner (R.C. Roberts) was in excess of $300,000. Storm event sizing is an important factor in flow control as is rain on snow events, the most common form of flooding within the watershed. Data collection beginning in 1904 through present day have shown 7 day sustained flows in excess of 1,200 cfs on a two year occurrence. USGS stream gauge for readings the Susan River are taken at Hobo Camp and can be found on the USGS website.

Currently minimal flood control is achieved in the existing system. This is a combination of factors ranging from undersized dams and canal, to lack of flow measurement at key sections of the river. Poorly managed flood waters are a contributing factor to fields being damaged and water shortages experienced in the basin. Water masters with advanced notice of storm flows leaving Hog Flat through radio SCADA would have 12 hours to prepare the system. With better functioning dams at Johnstonville and Colony, an enlargement of AB canal and Hog Flat Reservoir brought online, flood waters could be flashed to individuals fields, used to fill additional storage facilities, and increase yearly yields. Flood control will be most economically obtained and implemented through the update of upper river measurement structures and the restoration of Johnstonville Dam.

7.3 SEEPAGE AND LEAKAGE LOSSES

Seepage and leakage losses are the greatest detriments to the current watershed health. The current system loses, on average, 58.5% of the measured flows to seepage and leakage, as measured downstream from Leavitt Lake. Additionally, leakage losses account for about 1.5% of the total flows through the system. This results in an off-farm efficiency of only 40%, well below the Bureau of Reclamations range of 83-88%. During the 2011 irrigation season, 150 days, the canal system from Leavitt Lake experienced approximately 25,000 Ac-ft in losses, 24,000 Ac-ft being in the form of seepage. The loss of this water stresses the current ecosystem and adds to erosion and bank incision through increased flows. By remedying this issue, HLVRCD and LIC could allow more water to remain in natural channels (Susan River, Willow Creek, Lassen Creek, Gold Run Creek, and Paiute Creek) which would lower water temperatures and increase flows into Honey Lake. Additionally, by reducing the seepage and leakage losses, there would be more water available for starting crops for the next grow season, reducing overall the water demand.

7.4 WATER & RESERVOIR MANAGEMENT

The reservoirs currently operate as storage for LIC and have a capacity of 31,500 Ac-ft. The combined surface area of the storage system is 5,360 acres. The pan evaporation rate of 38.69 inches with a pan factor of 0.7 was obtained from NOAA and was taken at Willow Creek. Total evaporation from the system can be modeled by $E = K*E_1$ where:

E = Evaporation Rate

K = Pan Factor

E_1 = Pan Rate

The rate was calculated to be 27.08 inches. Multiplied across the total surface area of the reservoirs, and a total evaporation loss of 12, 097 Ac-ft per year is realized. Additionally, many of the measuring devices leaving the reservoirs are old and outdated, making accurate flow measurement unfeasible.

7.5 IRRIGATION METHODS, ON-FARM IMPROVEMENTS

Currently, the majority of irrigation users utilize flood irrigation methods. Less than ten of the users within the LIC utilize sprinklers and only one parcel has underground flood irrigation installed. The majority of the farms have return systems, but the average rate of return is only 10% of provided flows. Of these flows, it is estimated that 60% are lost to seepage and leakage. The current farming practices result in an on farm efficiency range of 59-66%, with the value being closer to 59% according to the Bureau of Reclamation. Coupled with an off farm efficiency of approximately 40%, the total system efficiency range is 23 - 25%.

To improve the on-farm systems, flood irrigation should be updated to either below ground irrigation, where the effects of evaporation are lessened, or sprinklered systems. Sprinklered systems are more efficient, can be moved to areas of need, and apply water in a more efficient manner. The current irrigation supply does not support sprinklered systems without the use of individual pumps, but a move to pressurized pipe within the LIC and HLVRCD would allow for agricultural users to update their irrigation methods.

7.6 WATER MEASUREMENT AND SCADA SYSTEMS

Water Measurement is currently recorded by visual inspections of each flow device by the respective water masters of each district. SCADA systems, which are Supervisory Control and Data Acquisition units would allow for the remote monitoring of not only measurement devices, but the operation of diversion and water storage gates as well through the use of actuators. SCADA systems, coupled with radio control towers, allow for secure control of structures and measurement of flows remotely or at a central command station. Additionally, SCADA will allow for the publication of water flows for the State Water Control Board to view and made available for public information as well.

7.7 RECOMMENDED ACTIONS

7.7.1 HLVRCD

HLVRCD should immediately begin applying for grants and federal funding to rectify the current condition of their structures as well as implement functional measurement devices. As of July 16, 2012, the HLVRCD board has applied for funding through the Sierra Nevada Conservancy to restore the following seven structures: Susan River into McCoy Parshall, McCoy Outlet Parshall, Bridge Creek Parshall, 100 Inch Weir, Ramsey Parshall/Headgate, Hog Flat Outlet Parshall, and Buffum Parshall. These seven structures will provide accurate and reliable flow measurement of the upper river system allowing for flood planning and better water movement operations. By restoring these structures and outfitting them with radio controlled SCADA, the water masters of both districts will be better equipped to monitor high and low flows and manage the system better, specifically Johnstonville Dam which has the greatest ability to redirect high water flows into less destructive channels.

HLVRCD should continue to allocate or seek funding for the replacement of the following seven structures as their operation and measurement is critical to the health and functionality of the upper system: Gold Run Diversion, McCoy Flat Reservoir Emergency Spillway, Johnstonville Dam, Mill Diversion, Caribou Outlet, Caribou Spillway, and Lassen Street Measuring Device. Caribou is the headwaters of the system and should be closely monitored and regulated to ensure maximum water capture. Lassen Street Measuring Device would be another useful measuring station to gauge flood waters. Mill Diversion has failed and poses a risk to health and safety in its current state. Johnstonville Dam has the ability to handle 400 cfs safely and is a critical piece in flood control. Should that dam fail, it would cause catastrophic damage to the river channel, downstream structures, and the local economy through the inability to get water to the agricultural end users. Should a dam be chosen for immediate action, Johnstonville Dam is first priority for overall system health with Gold Run Diversion number being in the worst condition.

The remaining five structures are equally important as they control the functionality of the lower system and are listed as follows: Toscani Dam, Colony Dam, Charpontier Dam, Window Dam, and Virgil's Parshall. Improving the above listed structures will allow for almost total flow measurement capabilities for the system as well as better flow management. Better management and flow recording will equate to an increase in water supply improving not only the quality and quantity of crops, but the local ecosystems as well.

7.7.2 **LIC**

It is recommended that LIC explore the possibility of replacing their open water channels with pressurized pipe. Pulling water from Lake Leavitt through the use of a pump house, LIC could distribute irrigation water in low pressure pipes to the end users. Making this improvement would increase the off-farm efficiency from 40% to an efficiency of 99% if only taking into account water loss. The cost of electricity to run the pumps would be offset by the additional 24,000 Ac-ft of water that would be available to the system. If LIC were to elect to line the channels and replace defunct structures along the canals, the end efficiency would be within the 83-88% range, resulting in an increase of deliverable flows in the range of 34,000 - 36,000 Ac-ft per annum. On farm efficiencies will only be improved through the implementation of different agricultural methods, specifically a sprinkler system or subterranean irrigation methods. If no changes are made by the end users, on-farm efficiencies will remain the same, but total system efficiencies will increase from 23-25% to 49-58%, resulting in a deliverable and usable flow ranging from 20,000 Ac-ft - 23,739 Ac-ft per annum.

LIC should investigate the possibility of enlarging AB canal to handle flood waters safely. The current capacity of 250 cfs should be expanded to as large as feasible to better handle the yearly 1,000 plus cfs flows, so the water can be stored in Lake Leavitt and strain removed from Johnstonville Dam. Other investigations that LIC should undertake include connecting McCoy Flat to Hog Flat, hydro-electric possibilities, and a more in depth analysis of their existing canal system.

7.8 POTENTIAL CUMULATIVE WATER CONSERVATION

The potential for water conservation in the Susan River Watershed is very large. The greatest conservation will occur if LIC chooses to go forward with DEC's recommendation of piping the entire system and encouraging on farm changes to irrigation methods. Singular improvements will result in small gains, but increases to the overall supply nonetheless. Better management of flows and a reduction in leaking at any of the structures listed can result in a 1% increase of available flows at that structure. In aggregate, small savings will result in a larger quantity of water available for agriculture, recreation, and habitat restoration.

8.0 FUNDING ALTERNATIVES

There are many sources of public funds available to the district in many different forms Matching funds, strait grants, revolving state loans, the list is quite large. With the changing political landscape in Washington, it is important to stay abreast of new funding modes. AWEP was a program historically utilized within the watershed but as of 2012, no longer exists. The Terminal Lakes Fund has been refunded and allows for funds to be applied for and granted on a need and first come basis. Below is a list of some of the available funds that DEC is familiar with and that RCD have utilized in the past. Funding sources are too numerous to list in entirety, so below are a few sources that have not been utilized in the past.

8.1 NAWCA FUNDS

NAWCA is the North American Wetlands Conservation Act. The funds fall into two categories, small grants and standard grants. They are matching grants programs that support public-private partnerships carrying out projects that further the goals of wetland preservation. These would be excellent funds for working on the reservoirs to help reduce botulism and algae blooms during the summer months. These grants are administered by the Intermountain West Joint Venture Group. Specifically the Non-Breeding Waterfowl Priority Landscapes of SONEC apply directly to the Honey Lake Basin as they are significant breeding grounds. These grants require a 501(3c) for consideration.

8.2 USBR WATER SMART GRANTS

These grants offered by the USBR are cost shared funding grants for water and energy efficiency as well as system optimization review grants. They can be applied to any project that optimizes system management resulting in improved efficiency. These grants would be applicable to any project on the Susan River or tributaries thereof.

8.3 DESERT TERMINAL LAKES PROGRAM

Enacted into law May 13, 2002, this program has recently been refunded. These funds are meant to provide water to at-risk natural desert terminal lakes. The funds are available until expended and may be used as grants and cooperative extensions, i.e. as the funds necessary to match other forms of funding.

Appendix A
HLVRCD and LIC Structures Ranking Matrix

Honey Lake Valley Resource Conservation District
Dyer Engineering Consultants, Inc.
Irrigation Data Matrix Assessment

Name: ____________________
Agency: ____________________
Assessment Date: ____________________

Date Assessed: 05/15/2012
Assessed by: DRG

Note: 1 is the lowest score in order of importance, 5 is the highest. See last page for instructions.

Name	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure	Total Score	Photo (Y/N)	Independent Ranking Assessment	Notes
Diversion Number 2	5	5	5	1	2	3	5	31	Y	32	Was removed from this Study per public comment.
Charpontier Dam	4	3	5	2	2	3	5	29	Y	30	
Gold Run Creek	4	3	5	1	2	3	5	28	Y	29	
Toscani Dam	5	4	4	2	2	3	4	28	N	29	
JOHNSTONVILLE DAM	5	5	4	1	2	3	4	28	N	29	
100 in. Weir	4	2	5	1	2	3	5	27	Y	28	
Old Channel Weir	3	3	5	1	2	3	5	27	Y	28	
McClelland #4 Head Gate	4	4	4	2	2	3	4	27	N	27	
BENTLEY DAM	3	2	5	2	2	3	5	27	Y	27	
Gold Run, Diversion 187	2	3	5	1	2	3	5	26	Y	27	
Paiute Creek	4	1	5	1	2	3	5	26	Y	27	
Lassen Creek	4	1	5	1	2	3	5	26	N	26	
Davis Dam	4	4	3	2	2	3	4	25	Y	26	
McClelland #3	4	5	3	2	2	3	3	25	N	26	
UNKNOWN	2	2	5	1	2	3	5	25	N	25	
Deep Cut Dam	4	4	3	2	2	3	3	24	N	25	
Gold Run	4	3	3	3	2	3	3	24	Y	25	
Gold Run, Richmond Rd	2	1	5	1	2	3	5	24	N	25	
Mill Diversion	4	2	4	3	2	1	4	24	Y	25	
Ramsey Ditch Head Gate	2	3	5	1	2	1	5	24	Y	25	
Walsh Dam	3	5	3	2	2	3	3	24	Y	25	
Willow Creek	4	1	5	1	2	1	5	24	Y	25	
Window Dam	4	4	3	2	2	3	3	24	Y	25	
Woodstock Dam	4	4	4	1	2	1	4	24	Y	25	
WHIRLEY CREEK (TO MCCOY RESIVOIR)	3	1	4	1	5	1	5	24	Y	25	
GUSTI DIVERSION	1	2	5	1	2	3	5	24	Y	24	
JOE EGAN ABONDONED	1	2	5	1	2	3	5	24	N	24	
JENKINS DAM	3	2	4	1	2	3	5	24	N	24	
UNKNOWN	1	2	5	1	2	3	5	24	N	24	
Colony Dam	3	1	4	2	2	3	4	23	Y	24	
Mapes Dam	4	3	3	2	2	3	3	23	Y	23	
HOG FLAT PARSHALL	3	1	5	1	2	1	5	23	N	23	
Old Channel Headgate	3	3	4	1	2	1	4	22	Y	23	
Toscani, Div 51-52	3	3	3	2	2	3	3	22	N	23	
Toscani, Div 53	3	3	3	2	2	3	3	22	N	23	
Willow Creek - DFG	4	5	3	1	2	1	3	22	N	23	
Willow Creek DFG	4	2	4	1	2	1	4	22	N	23	
Barham Dam, Pump	3	3	3	2	2	3	3	22	Y	22	
Mapes Parshall	4	1	3	3	2	3	3	22	Y	22	
Diversion #75	1	5	3	1	2	3	3	21	Y	22	
Diversion #78	1	5	3	1	2	3	3	21	Y	22	
Susan into McCoy	5	1	3	1	2	3	3	21	Y	22	
Willow Creek, Miller	4	2	3	1	2	3	3	21	N	22	
McCoy Dam - Release Gate	5	1	3	1	2	3	3	21	Y	22	
BUFFUM DAM	4	2	3	1	2	3	3	21	N	22	
Willow Creek, Belfast	4	4	3	1	2	1	3	21	N	21	
ALEXANDER B DITCH - DENTENBURG DIVERSION 2	1	2	4	1	2	3	4	21	N	21	
ALEXANDER B DITCH - HANLON DIVERSION	1	2	4	1	2	3	4	21	N	21	
KAPUSCHINSKY DIVERSION	1	2	4	1	2	3	4	21	Y	21	

Name	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure	Total Score	Photo (Y/N)	Independent Ranking Assessment	Notes
RAMSEY WOOD PUMP	3	2	3	1	2	3	4	21	N	21	
RAUCH DIVERSION 1	2	2	3	2	2	3	4	21	Y	21	
REID - COOLEY DIVERSION	3	2	3	1	2	3	4	21	N	21	
SMITH - PAROLI DIVERSION	1	2	3	3	2	3	4	21	Y	21	
ABANDONED	1	2	3	3	2	3	4	21	N	21	
Baxter DFG	3	4	3	1	2	1	3	20	Y	21	
Bridge Creek	4	3	3	1	2	1	3	20	Y	21	
Diversion 56	1	2	3	2	2	3	4	20	N	21	No Measurement Device Present.
Mahle Diversion	4	2	3	2	2	1	3	20	Y	21	
McCoy Dam - Release Gate	4	3	3	1	2	1	3	20	Y	21	
Virgil's Parshall	4	1	2	3	2	3	3	20	Y	21	
Willow Creek DFG	4	3	3	1	2	1	3	20	N	21	
McCoy Outlet	4	3	3	1	2	1	3	20	Y	21	
Bridge Creek	4	3	3	1	2	1	3	20	Y	21	
BUFFUM PARSHALL	4	1	3	1	2	3	3	20	N	21	
MCCOY SPILLWAY	3	4	3	1	2	1	3	20	Y	21	
CAPEZZOLI DITCH - RICHARDS DIVERSION 4	2	2	3	1	2	3	4	20	Y	20	
MARTIN DIVERSION 1	2	2	3	1	2	3	4	20	Y	20	
MARTIN DIVERSION 2	2	2	3	1	2	3	4	20	Y	20	
SHRODE LANE TAP	1	2	3	3	2	3	3	20	Y	20	
WEST DITCH - WIDING DIVERSION	2	2	3	1	2	3	4	20	N	20	
Non Critical Structures											
Baxter, Diversion 8	3	1	4	1	2	1	3	19	Y	19	
Brockman Slough	2	2	3	1	2	3	3	19	N	19	
Dill Slough	2	2	3	1	2	3	3	19	Y	19	
Diversion 95	1	3	3	1	2	3	3	19	Y	19	
Turkeytown Dam	4	4	2	1	2	3	1	19	N	19	
BERTOTTI DIVERSION 2	1	2	2	3	2	3	4	19	Y	19	
ELDORADO TAP 2 (MORTSON DITCH)	2	2	3	1	2	3	3	19	N	19	
ELDORADO TAP 5 (LOCUST DITCH)	2	2	3	1	2	3	3	19	N	19	
EMERGENCY OVERFLOW	2	2	3	1	2	3	3	19	N	19	
JOE EGAN PUMP	2	2	3	1	2	3	3	19	N	19	
LANE DITCH MEASURING DEVICE	2	1	3	1	2	3	4	19	N	19	
LANE DITCH - LANE DIVERSION	2	2	3	1	2	3	3	19	N	19	
LANE DITCH - HARRY MCCLURE DIVERSION	2	2	3	1	2	3	3	19	N	19	
MCCOY SCREW GATE 1	1	2	4	1	2	1	4	19	Y	19	
MORTSON DITCH - ELDORADO DIVERSION	2	2	3	1	2	3	3	19	N	19	
MORTSON DITCH - OLSEN DIVISION	2	2	3	1	2	3	3	19	N	19	
PARADY - MARTIN DIVISION	2	2	3	1	2	3	3	19	Y	19	
RAMSEY WOOD LOW TAP 2	1	2	3	1	2	3	4	19	N	19	
RAUCH DIVERSION 2	1	2	3	1	2	3	4	19	Y	19	
SMITH DIVERSION	1	2	3	1	2	3	4	19	Y	19	
VAN DOORN - BASS DIVERSION	2	2	3	1	2	3	3	19	N	19	
VAN DOORN DITCH - JENKINS DIVERSION	1	2	3	1	2	3	4	19	N	19	
VAN DOORN DITCH - WEIMAR DIVERSION	1	2	3	1	2	3	4	19	N	19	
VINCE FERRIERA PUMP 1	2	2	3	1	2	3	3	19	N	19	
VINCE FERRIERA PUMP 2	2	2	3	1	2	3	3	19	N	19	
VINCE FERRIERA TAP	1	2	3	1	2	3	4	19	N	19	
VINCE FERRIERA UNDERGROUND TAP	1	2	3	1	2	3	4	19	N	19	
WALTMAN TAP	2	2	3	1	2	3	3	19	N	19	
WEMPLE TAP 1	2	2	3	1	2	3	3	19	N	19	
WEMPLE TAP 2	2	2	3	1	2	3	3	19	N	19	
UNKNOWN (TAP)	1	2	3	1	2	3	4	19	N	19	
UNKNOWN (TAP)	1	2	3	1	2	3	4	19	N	19	
UNKNOWN (PUMP TAP)	1	2	3	1	2	3	4	19	N	19	
Gaging Station, Hog to Susan	4	1	3	1	2	1	3	18	Y	18	
Hartson Slough - Mapes Road	2	2	3	2	2	1	3	18	Y	18	

Name	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure	Total Score	Photo (Y/N)	Independent Ranking Assessment	Notes
McClelland #1	4	5	1	1	2	3	1	18	N	18	
McClelland #2	4	5	1	1	2	3	1	18	Y	18	
McCoy Outlet	4	1	3	1	2	1	3	18	Y	18	
Turkeytown Flow Structure	3	2	3	1	2	3	1	18	N	18	
Willow Creek - Jacob Nioahoas	2	1	3	1	2	3	3	18	N	18	
Gaging Station, Hog to Susan	4	1	3	1	2	1	3	18	Y	18	
ALEXANDER DITCH - ALEXANDER B DIVERSION	2	2	2	2	2	3	3	18	N	18	
BERTOTTI DIVERSION 4	1	2	2	2	2	3	4	18	Y	18	
BERTOTTI PUMP	1	2	3	1	2	3	3	18	Y	18	
BILL WALTER GATE 1	1	2	3	1	2	3	3	18	N	18	
BILL WALTER GATE 2	1	2	3	1	2	3	3	18	N	18	
BILL WALTER GATE 3	1	2	3	1	2	3	3	18	N	18	
BILL WALTER GATE 4	1	2	3	1	2	3	3	18	N	18	
BILL WALTER GATE 5	1	2	3	1	2	3	3	18	N	18	
BILL WALTER GATE 6	1	2	3	1	2	3	3	18	N	18	
BURTON TAP (MORTSON DITCH)	1	2	3	1	2	3	3	18	N	18	
COMINO TAP 1	1	2	3	1	2	3	3	18	N	18	
COMINO TAP 2	1	2	3	1	2	3	3	18	N	18	
COMINO TAP 3	1	2	3	1	2	3	3	18	N	18	
DENNIS WOOD 1	1	2	3	1	2	3	3	18	N	18	
DENNIS WOOD 2	1	2	3	1	2	3	3	18	N	18	
DENNIS WOOD 3	1	2	3	1	2	3	3	18	N	18	
DENNIS WOOD 4	1	2	3	1	2	3	3	18	N	18	
ELDORADO PUMP 1	1	2	3	1	2	3	3	18	N	18	
EAGLES TAP	1	2	3	1	2	3	3	18	N	18	
EAGLES TAP 2	1	2	3	1	2	3	3	18	N	18	
ELDORADO PUMP 2	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 0	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 00	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 3	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 4	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 6	1	2	3	1	2	3	3	18	N	18	
ELDORADO TAP 7	1	2	3	1	2	3	3	18	N	18	
FRUZZA TAP	1	2	3	1	2	3	3	18	N	18	
KURT MORAN	1	2	3	1	2	3	3	18	N	18	
LANE TAP	1	2	3	1	2	3	3	18	N	18	
LILLARD TAP (MORTSON DITCH)	1	2	3	1	2	3	3	18	N	18	
NURSERY PUMP 1	3	2	2	1	2	3	3	18	N	18	
NURSERY PUMP 2	3	2	2	1	2	3	3	18	N	18	
NURSERY PUMP 3	3	2	2	1	2	3	3	18	N	18	
PARKER/DILTZ TAP	1	2	3	1	2	3	3	18	N	18	
RIVER TAP 1 (COMINO, CABODI, FERRIS)	1	2	3	1	2	3	3	18	N	18	
RIVER TAP 2 (FERRIS, DARRELL WOOD)	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 1	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 2	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 3	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 4	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 5	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 6	1	2	3	1	2	3	3	18	N	18	
RAMSEY WOOD HIGH TAP 7	1	2	3	1	2	3	3	18	N	18	
REESE - CANNON DIVERSION	2	2	2	1	2	3	4	18	N	18	
REEVIS TAP	1	2	3	1	2	3	3	18	N	18	

Name	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure	Total Score	Photo (Y/N)	Independent Ranking Assessment	Notes
REEVIS TAP 2	1	2	3	1	2	3	3	18	N	18	
REEVIS TAP 3	1	2	3	1	2	3	3	18	N	18	
RICHARDS TAP	1	2	2	2	2	3	4	18	Y	18	
SHRODE DITCH MEASURING DEVICE	2	1	3	1	2	3	3	18	N	18	
VAN DOORN TAP	1	2	3	1	2	3	3	18	N	18	
VAN DOORN DITCH - BEAMON DIVERSION	2	2	2	1	2	3	4	18	N	18	
WEST DITCH TAP	1	2	3	1	2	3	3	18	N	18	
Barham Dam	3	4	1	2	2	3	1	17	Y	17	
Ellena Diversion	2	2	3	1	2	1	3	17	N	17	
McCoy Dam	4	4	1	1	2	3	1	17	Y	17	
Old Channel Weir	3	3	2	1	2	3	1	17	Y	17	
Ramsey Ditch	2	2	3	1	2	1	3	17	N	17	
McCoy Dam	4	4	1	1	2	3	1	17	Y	17	
ALEXANDER DITCH - EAGLE DIVERSION 1	2	2	2	1	2	3	3	17	N	17	
ALEXANDER DITCH - EAGLE DIVERSION 2	2	2	2	1	2	3	3	17	N	17	
ALEXANDER B DITCH - BRADBURY DIVERSION	2	2	2	1	2	3	3	17	N	17	
ALEXANDER B DITCH - WINKLER DIVERSION 1-2	1	2	2	1	2	3	4	17	N	17	
BERTOTTI DIVERSION 1	1	2	2	1	2	3	4	17	Y	17	
BERTOTTI DIVERSION 3	1	2	2	1	2	3	4	17	Y	17	
BERTOTTI DIVERSION 5	1	2	2	1	2	3	4	17	Y	17	
CAPEZZOLI DITCH - RICHARDS DIVERSION 2	2	2	2	1	2	3	3	17	N	17	
RAUCH - MARTIN DIVERSION	1	2	2	1	2	3	4	17	Y	17	
REESE TAP	1	2	2	1	2	3	4	17	N	17	
WHITING PUMP	2	2	3	1	2	1	3	17	N	17	
Lift Pump	4	3	1	1	2	3	1	16	N	16	
Lift Pump	4	3	1	1	2	3	1	16	N	16	
Susan River - DFG Diversion	5	3	1	2	2	1	1	16	N	16	
Brubeck Dam	2	4	1	2	2	3	1	16	N	16	
Fleming Head Gate	1	2	2	3	2	1	3	16	Y	16	
Old Channel, Fletcher's	3	4	1	1	2	3	1	16	N	16	
Ramsey Ditch Parshall Flume	2	1	3	1	2	1	3	16	Y	16	
ALEXANDER TAP	1	2	2	1	2	3	3	16	N	16	
ALEXANDER B DITCH - DENTENBURG DIVERSION	1	2	2	1	2	3	3	16	N	16	
ALEXANDER B DITCH MEASURING DEVICE	1	1	2	1	2	3	4	16	N	16	
ALEXANDER B DITCH MEASURING DEVICE 2	1	1	2	1	2	3	4	16	N	16	
ALEXANDER B DITCH - WINKLER/WAGNER DIVERSION	1	2	2	1	2	3	3	16	N	16	
BRIDGE CREEK (TO MCCOY RESIVOIR)	1	2	2	1	2	3	3	16	Y	16	
CALTRANS SNOW MEASURE	1	2	2	1	2	3	3	16	N	16	
LEVAITT LAKE DAM	3	4	1	1	2	3	1	16	N	16	
HOG SCREW GATE	1	2	3	1	2	1	3	16	N	16	
A&B Dam, Diversion 40	3	4	1	2	2	1	1	15	N	15	
Fleming Dam	3	4	1	2	2	1	1	15	N	15	
Old Channel, Diversion 21	3	3	1	1	2	3	1	15	N	15	
Old Channel, Mediolea's	3	3	1	1	2	3	1	15	N	15	
Susan River - DFG Diversion	5	2	1	2	2	1	1	15	N	15	
Willow Creek weir structure	4	2	1	1	2	3	1	15	N	15	
CAPEZZOLI DITCH - RICHARDS DIVERSION	2	2	1	3	2	3	1	15	Y	15	
Barham Dam - Head Gate	1	3	1	2	2	3	1	14	Y	14	
Brubeck Headgate	1	3	1	2	2	3	1	14	N	14	
Dill Slough - Capezzoli Rd	2	2	1	2	2	3	1	14	N	14	
Diversion 91	1	3	1	2	2	3	1	14	N	14	
Hog Flat Release Gate	4	3	1	1	2	1	1	14	Y	14	
Toscani Parshall Flume	3	1	1	2	2	3	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	

Name	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure	Total Score	Photo (Y/N)	Independent Ranking Assessment	Notes
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Willow Creek DFG	4	3	1	1	2	1	1	14	N	14	
Hog Flat Release Gate	4	3	1	1	2	1	1	14	Y	14	
CAPEZZOLI DAM	1	2	1	3	2	3	1	14	Y	14	
CAPEZZOLI TAP	1	2	1	3	2	3	1	14	Y	14	
Diversion #74	1	3	1	1	2	3	1	13	Y	13	
Diversion 90	1	2	1	2	2	3	1	13	N	13	
Diversion 94	1	2	1	2	2	3	1	13	N	13	
CAPEZZOLI DITCH - RICHARDS DIVERSION 3	2	2	1	1	2	3	1	13	Y	13	
REID DIVERSION 1	2	2	1	1	2	3	1	13	Y	13	
REID DIVERSION 2	2	2	1	1	2	3	1	13	N	13	
REID - WHITLEY DIVERSION	2	2	1	1	2	3	1	13	Y	13	
Hartson Slough - Capezzoli Rd	2	2	1	2	2	1	1	12	N	12	
Hartson Slough - DFG Diversion	2	2	1	2	2	1	1	12	N	12	
Murrer Ditch Terminous	2	1	1	1	2	3	1	12	N	12	
Willow Creek DFG	4	1	1	1	2	1	1	12	N	12	
AB CANAL DAM	3	2	1	1	2	1	1	12	Y	12	
RICHARD EGAN PUMP	1	2	1	1	2	3	1	12	N	12	
ELDORADO TAP 1	1	2	1	1	2	3	1	12	N	12	
Head of Willow Creek								0	Y	0	
MCCOY CABIN								0	N	0	

Matrix Ranking References

Rank	Conveyance Type	Function	Problem Characterization	Secondary Problems	Date Constructed	Use	Condition of Structure
1	Field Gate	Measure	None	None	2000-Present	Non-Agricultural	Foundation sound, concrete not chipped, no signs of leaking
2	Ditch	Divert	Reduced/Limited Functionality (Maintain)	Overgrown	1976-2000	Not Used	Foundation sound, concrete contains small chips, good flow
3	Slough	Measure & Divert	Channel Rehab/Lack of Functionality (Repair)	Channel Rehab	1951-1975	Agricultural	Foundation may have small damage, larger cracking in structure, flow inhibited
4	Creek	Impound	Leaking/Undercutting	Not Used	1926-1950	Not Used	Damage to overall structure, still functional but not efficient, leaking or undercutting, rotted or rusted gates
5	River	Impound & Divert	High Failure Potential	Not Used	1900-1925	Not Used	Unfunctional, failure imminent, needs immediate service

Notes on Ranking:

1. The higher the score, the more critical the rehab/replacement of the listed structure.
2. Problem Characterization was given a weighting factor of two so that it would not be unduly influenced by the other rankings.
3. Unless otherwise stated, the condition of the structure was assumed to be rated a 3.
4. Rows highlighted in Pink are structures that DCE had no existing data on.
5. The cutoff score of 20 or above for critical structures was determined by taking the top 30% of scores.
6. Cells denoted by: Are eveluated structures.

Appendix B
Calculations and Seepage Rates from Irrigation Canals

Slough/Canal/Ditch Seepage Losses

Condition	Length (miles)	Ksat Class by Percentage	Ksat (in/hr)	Ksat (ft/day)	Length of Conveyance by Ksat Percentage (miles)	Depth to Water Table (cm)	Depth to Water Table (ft)	Seepage Loss (ft^3/Day-sf)	Area sf (assumed 2' perimeter times length of canal, ditch, slough)	Seepage Losses (ft^3/day)	Seepage Losses (ac-ft/year)
Untreated Canal	16.3	61%	0.77	1.54	9.94	127.59	4.19	6.45	52,499.04	338,755.31	1,166.51
		34%	6.15	12.3	5.54	127.59	4.19	103.07	29,261.76	3,016,126.65	10,386.11
		5%	14.1	28.2	0.82	127.59	4.19	236.32	4,303.20	1,016,915.01	3,501.77
Untreated Ditch	9.3	61%	0.77	1.54	5.67	127.59	4.19	12.91	29,953.44	386,555.13	1,331.11
		34%	6.15	12.3	3.16	127.59	4.19	103.07	16,695.36	1,720,857.54	5,925.82
		5%	14.1	28.2	0.47	127.59	4.19	236.32	2,455.20	580,203.04	1,997.94
Lined Open Ditch	3.9	61%	0.05	0.1	2.38	127.59	4.19	0.84	12,561.12	10,526.22	36.25
		34%	0.05	0.1	1.33	127.59	4.19	0.84	7,001.28	5,867.07	20.20
		5%	0.05	0.1	0.20	127.59	4.19	0.84	1,029.60	862.80	2.97
Piped	0.25	61%	0.007	0.014	0.15	127.59	4.19	0.12	805.20	94.47	0.33
		34%	0.007	0.014	0.09	127.59	4.19	0.12	448.80	52.65	0.18
		5%	0.007	0.014	0.01	127.59	4.19	0.12	66.00	7.74	0.03
									Total Seepage:	7,076,823.64	24,369.23

Notes:	1. Darcy's modified equation was employed for infiltration above the water table. Q = Ksat*A*H where:
	Q = Flow (ft^3/s)
	Ksat = Saturated Hydraulic Conductivity
	A = Area
	H = Hydraulic Gradient (depth to water table, where large, unity is to be assumed)
	2. Ksat Values developed by NRCS in the Rapid Watershed Assessment
	3. Depth to Water Table was calculated off of NRCS Web Soil Survey. A weighted average of the soils within the watershed was used.

Appendix C
Cost Estimates

Honey Lake Valley Resource Conservation District
Dyer Engineering Consultants, Inc.
Preliminary Engineering Estimate
Date Assessed: 07/02/12
Assessed by: DRG

HONEY LAKE VALLEY RCD

Susan River at Lassen Creek Street Bridge				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$1,500.00	$1,500.00
Concrete w/ Rebar	CY	28	$700.00	$19,600.00
Earthwork	LS	100	$5.00	$500.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$2,600.00	$2,600.00
			Sub Total	$29,700.00
			Engineering Services	$4,000.00
			Total	$33,700.00

Susan River Into McCoy (Complex Weir)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$1,100.00	$1,100.00
Demolition	LS	1	$3,300.00	$3,300.00
Concrete w/ Rebar	CY	20	$700.00	$14,000.00
Earthwork	LS	1	$1,400.00	$1,400.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$2,400.00	$2,400.00
			Sub Total	$27,700.00
			Engineering Services	$4,000.00
			Total	$31,700.00

McCoy Outlet (12' Parshall)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$2,300.00	$2,300.00
Demolition	LS	1	$6,700.00	$6,700.00
Concrete w/ Rebar	CY	41	$700.00	$28,700.00
Earthwork	LS	1	$2,870.00	$2,870.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$4,900.00	$4,900.00
			Sub Total	$50,970.00
			Engineering Services	$8,000.00
			Total	$58,970.00

Bridge Creek (9" Parshall)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$300.00	$300.00
Steel Parshall Flume	EA	1	$2,500.00	$2,500.00
Earthwork	LS	1	$1,000.00	$1,000.00
SCADA	LS	1	$2,000.00	$2,000.00
Constuction Management	LS	1	$500.00	$500.00
			Sub Total	$6,800.00
			Engineering Services	$2,000.00
			Total	$8,800.00

100 Inch Weir (New Weir)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$2,300.00	$2,300.00
Demolition	LS	1	$3,000.00	$3,000.00
Concrete w/ Rebar	CY	41	$700.00	$28,700.00
Earthwork	LS	1	$3,000.00	$3,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$4,500.00	$4,500.00
			Sub Total	$47,000.00
			Engineering Services	$7,000.00
			Total	$54,000.00

Hog Flat Outlet (10' Parshall)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$2,300.00	$2,300.00
Demolition	LS	1	$6,700.00	$6,700.00
Concrete w/ Rebar	CY	38	$700.00	$26,600.00
Earthwork	LS	1	$5,000.00	$5,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$4,900.00	$4,900.00
			Sub Total	$51,000.00
			Engineering Services	$8,000.00
			Total	$59,000.00

Buffum Parshall				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$3,100.00	$3,100.00
Demolition	LS	1	$3,000.00	$3,000.00
Concrete w/ Rebar	CY	41	$700.00	$28,700.00
Earthwork	LS	1	$15,500.00	$15,500.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$6,100.00	$6,100.00
			Sub Total	$61,900.00
			Engineering Services	$9,000.00
			Total	$70,900.00

Ramsey Parshall				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$300.00	$300.00
12" Steel Parshall Flume	EA	1	$3,000.00	$3,000.00
Earthwork	LS	1	$500.00	$500.00
Demolition	LS	1	$900.00	$900.00
Concrete w/ Rebar	CY	5	$700.00	$3,500.00
Weir Gate (24" x 24")	EA	1	$1,500.00	$1,500.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$500.00	$500.00
			Sub Total	$15,700.00
			Engineering Services	$2,000.00
			Total	$17,700.00

Virgil's Parshall (10' Parshall)				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$2,100.00	$2,100.00
Demolition	LS	1	$6,200.00	$6,200.00
Concrete w/ Rebar	CY	38	$700.00	$26,600.00
Earthwork	LS	1	$2,660.00	$2,660.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$4,600.00	$4,600.00
			Sub Total	$47,660.00
			Engineering Services	$7,000.00
			Total	$54,660.00

Colony Dam Parshalls				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$500.00	$500.00
Mobilization	LS	1	$50,000.00	$50,000.00
Demolition	LS	1	$13,300.00	$13,300.00
Concrete w/ Rebar (12' Parshall Flume)	CY	82	$700.00	$57,400.00
Concrete w/Rebar (Dike)	LF	74	$85.00	$6,290.00
Earthwork	LS	1	$15,500.00	$15,500.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$11,100.00	$11,100.00
			Sub Total	$159,090.00
			Engineering Services	$24,000.00
			Total	$183,090.00

Honey Lake Valley Resource Conservation District
Dyer Engineering Consultants, Inc.
Preliminary Engineering Estimate
Date Assessed: 07/02/12
Assessed by: DRG

HONEY LAKE VALLEY RCD

McCoy Flat Reservoir Dam Overflow				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$38,100.00	$38,100.00
Demolition	LS	1	$30,000.00	$30,000.00
Concrete w/ Rebar	CY	670	$700.00	$469,000.00
Earthwork	LS	1	$75,000.00	$75,000.00
Radial Gates	EA	2	$75,000.00	$150,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$91,500.00	$91,500.00
		Sub Total		$860,600.00
		Engineering Services		$129,000.00
		Total		$989,600.00

Johnstonville Dam				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$36,100.00	$36,100.00
Demolition	LS	1	$30,000.00	$30,000.00
Concrete w/ Rebar	CY	670	$700.00	$469,000.00
Earthwork	LS	1	$46,900.00	$46,900.00
Radial Gates	EA	2	$75,000.00	$150,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$87,900.00	$87,900.00
		Sub Total		$826,900.00
		Engineering Services		$124,000.00
		Total		$950,900.00

Toscani Dam				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$28,000.00	$28,000.00
Demolition	LS	1	$25,000.00	$25,000.00
Concrete w/ Rebar	CY	500	$700.00	$350,000.00
Earthwork	LS	1	$50,000.00	$50,000.00
Radial Gates	EA	3	$35,000.00	$105,000.00
SCADA	LS	1	$10,000.00	$10,000.00
Constuction Management	LS	1	$67,000.00	$67,000.00
		Sub Total		$637,000.00
		Engineering Services		$96,000.00
		Total		$733,000.00

Colony Dam				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$43,800.00	$43,800.00
Demolition	LS	1	$15,000.00	$15,000.00
Concrete w/ Rebar	CY	750	$700.00	$525,000.00
Earthwork	LS	1	$100,000.00	$100,000.00
Radial Gates	EA	4	$35,000.00	$140,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$98,900.00	$98,900.00
		Sub Total		$929,700.00
		Engineering Services		$139,000.00
		Total		$1,068,700.00

Charpontier Dam				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$8,100.00	$8,100.00
Demolition	LS	1	$15,000.00	$15,000.00
Concrete w/ Rebar	CY	150	$700.00	$105,000.00
Earthwork	LS	1	$10,500.00	$10,500.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$16,700.00	$16,700.00
		Sub Total		$162,300.00
		Engineering Services		$24,000.00
		Total		$186,300.00

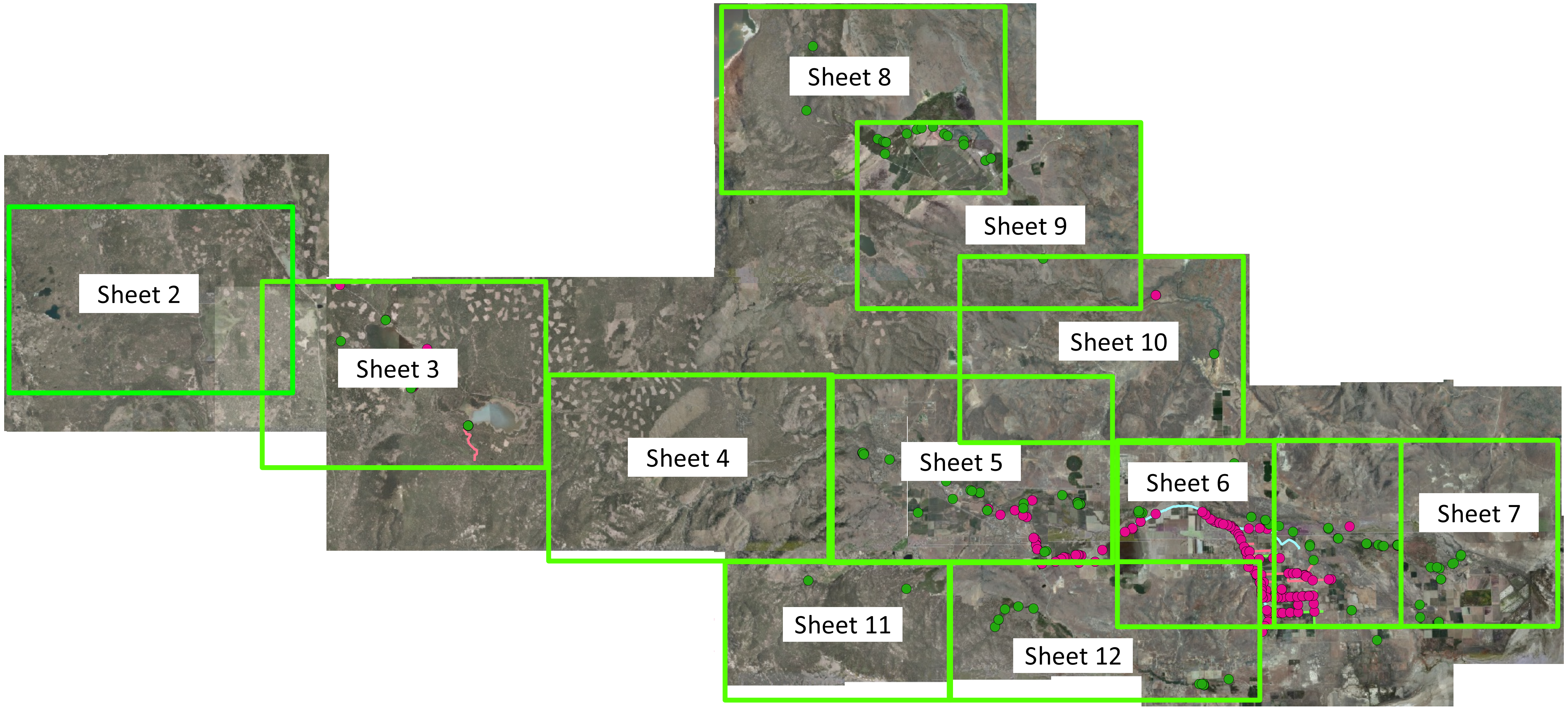
Window Dam				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$1,700.00	$1,700.00
Demolition	LS	1	$15,000.00	$15,000.00
Concrete w/ Rebar	CY	30	$700.00	$21,000.00
Earthwork	LS	1	$2,100.00	$2,100.00
Slide Gate	EA	1	$20,000.00	$20,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$4,800.00	$4,800.00
		Sub Total		$71,600.00
		Engineering Services		$11,000.00
		Total		$82,600.00

Gold Run Diversion				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$5,000.00	$5,000.00
Demolition	LS	1	$15,000.00	$15,000.00
Concrete w/ Rebar	CY	30	$700.00	$21,000.00
Earthwork	LS	1	$2,100.00	$2,100.00
Slide Gate	EA	1	$20,000.00	$20,000.00
SCADA	LS	1	$5,000.00	$5,000.00
Constuction Management	LS	1	$5,200.00	$5,200.00
		Sub Total		$75,300.00
		Engineering Services		$11,000.00
		Total		$86,300.00

Caribou Lakes Spillway				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$1,300.00	$1,300.00
Demolition	LS	1	$5,000.00	$5,000.00
Concrete w/ Rebar	CY	23	$700.00	$16,100.00
Earthwork	LS	1	$1,610.00	$1,610.00
Constuction Management	LS	1	$2,900.00	$2,900.00
		Sub Total		$28,910.00
		Engineering Services		$4,000.00
		Total		$32,910.00

Caribou Lakes Outflow				
Item	Unit	Qty.	Unit Cost	Item Cost
Admin	LS	1	$2,000.00	$2,000.00
Mobilization	LS	1	$400.00	$400.00
Demolition	LS	1	$5,000.00	$5,000.00
Concrete w/ Rebar	CY	5	$700.00	$3,500.00
Bentonite Slury	CY	5	$300.00	$1,500.00
Earthwork	LS	1	$350.00	$350.00
Constuction Management	LS	1	$1,300.00	$1,300.00
		Sub Total		$14,050.00
		Engineering Services		$2,000.00
		Total		$16,050.00

Appendix D
System Maps



Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

NHDFlowline

Index of Sheets

DYER ENGINEERING CONSULTANTS, INC.

5401 Longley Lane # 9
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(775) 852-1440

FIGURE 01 OF 12

HONEY LAKE VALLEY RCD

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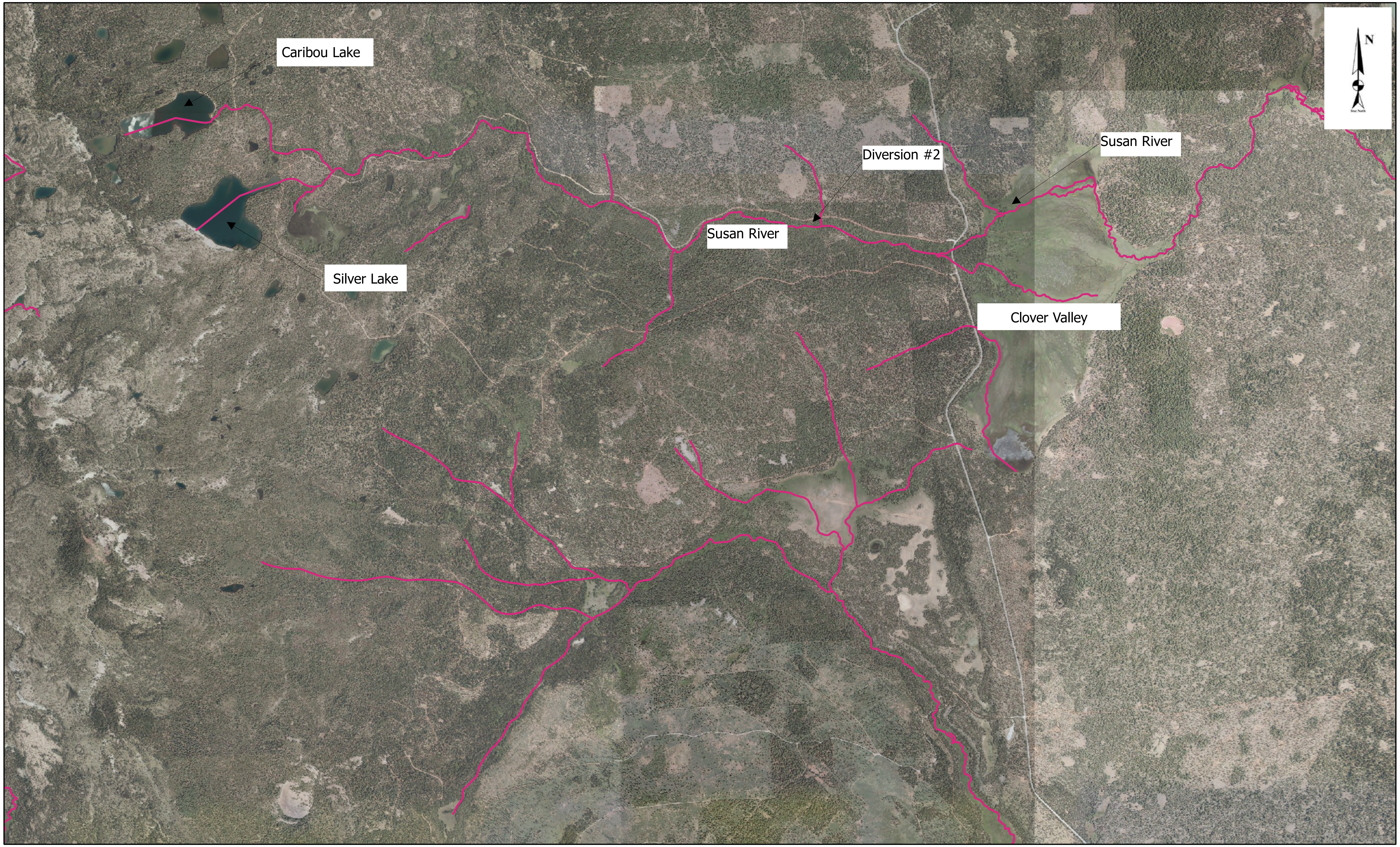

Legend

NHDFlowline

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

Susan River Headwaters Through Clover Valley

HONEY LAKE VALLEY RCD

1 0 1 2 3

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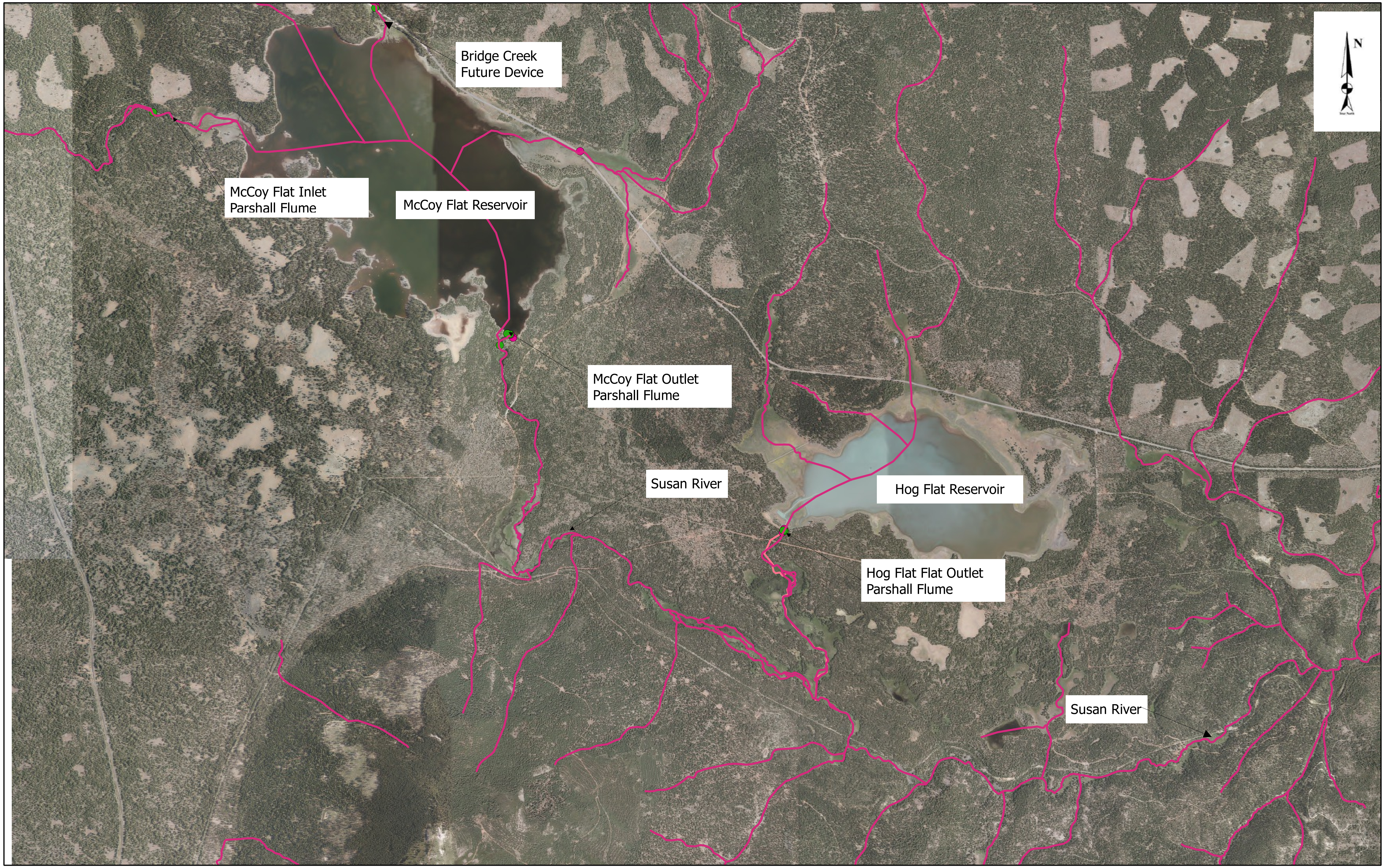
FIGURE 02 OF 12



HONEY LAKE VALLEY RCD

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Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

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NHDFlowline

Susan River Between McCoy Flat & Hog Flat Reservoirs

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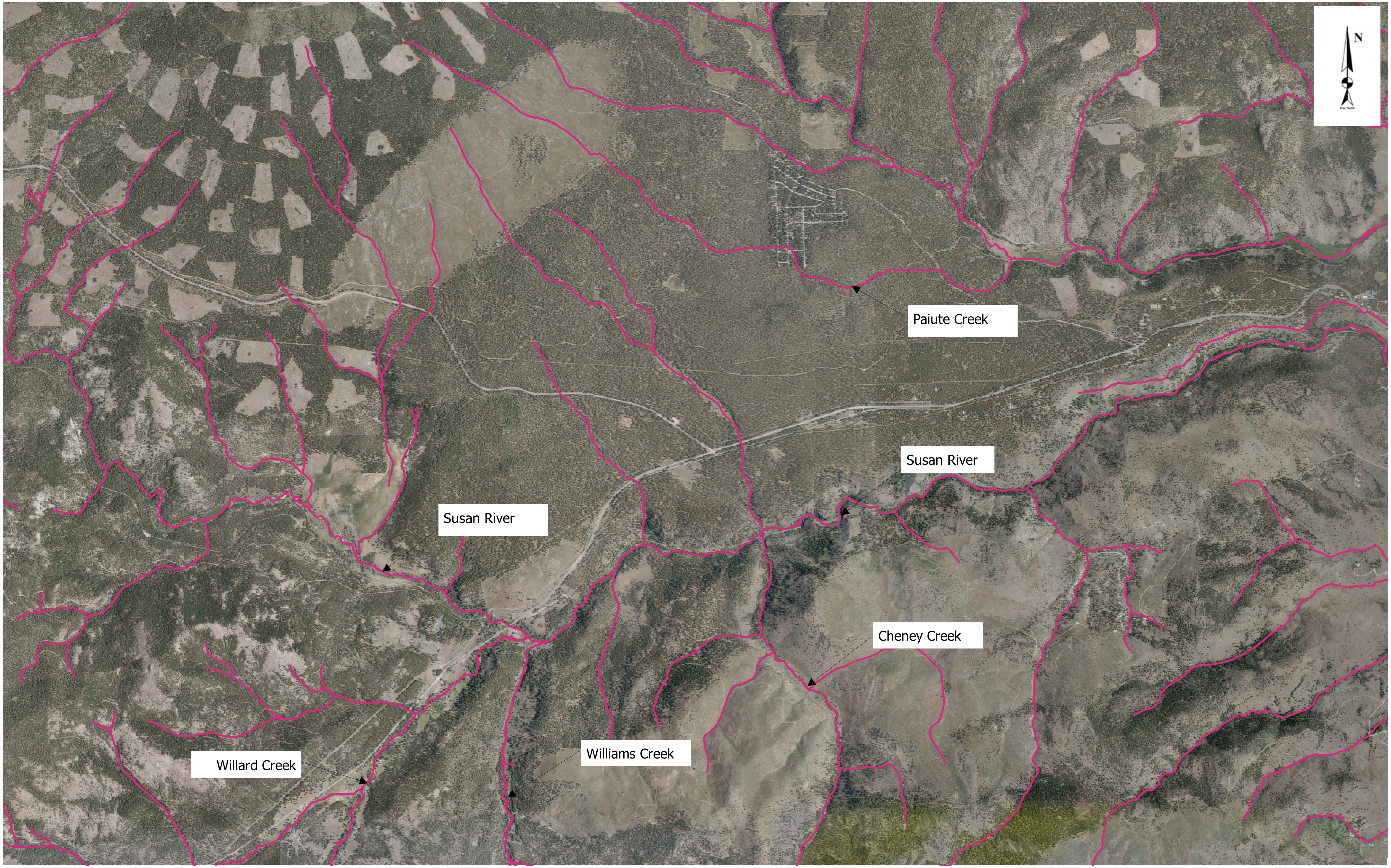
FIGURE 03 OF 12



HONEY LAKE VALLEY RCD

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Legend

- Rivers & Creeks
- HLVRCD Stuctures
- LIC Structures
- LIC Open Ditch - Unlined
- LIC Open Ditch - Lined
- LIC Distribution Canal
- LIC Conveyance Pipe

Susan River Between Hog Flat & Hobo Camp

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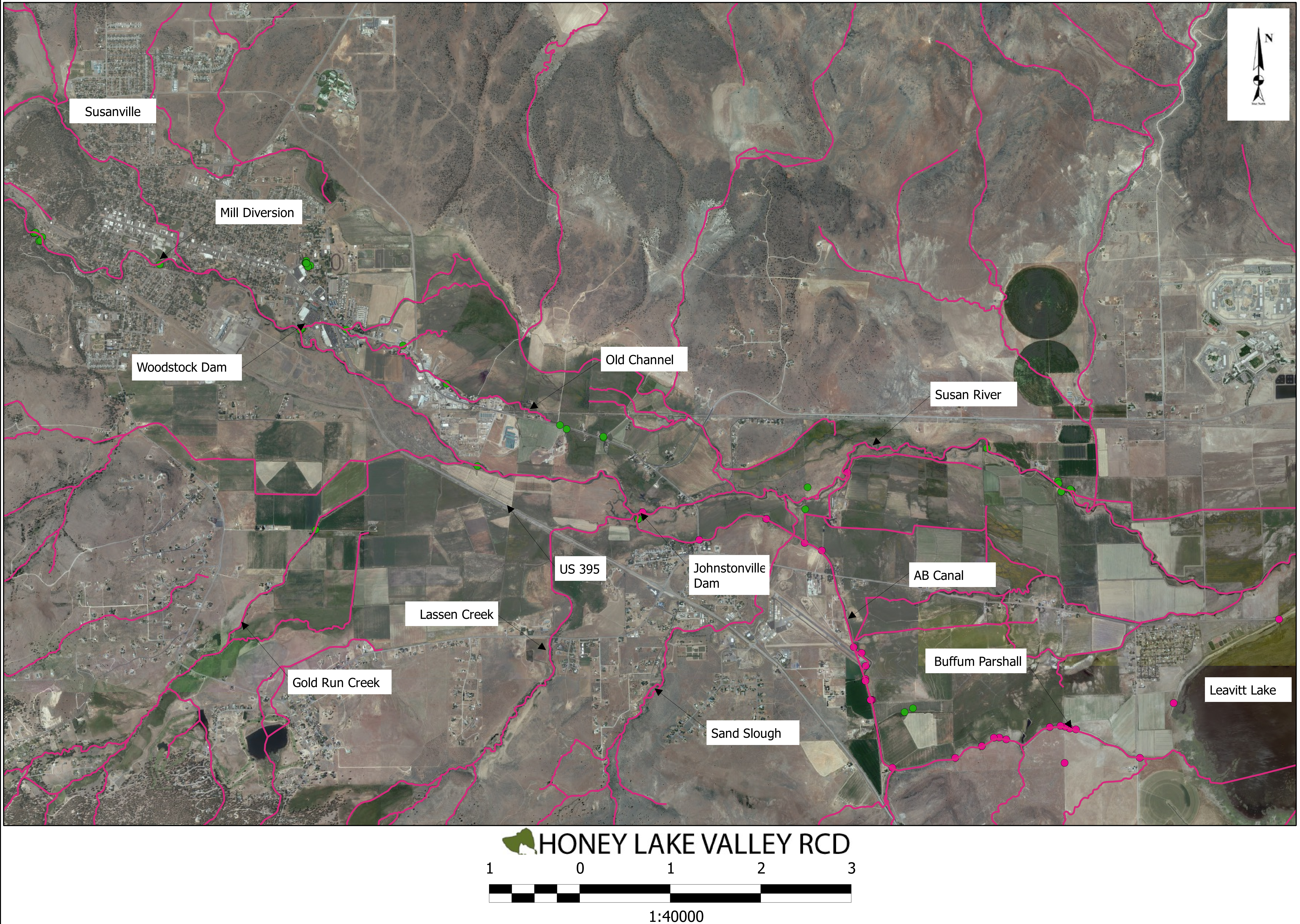
FIGURE 04 OF 12



Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

Susan River and LIC Canal Network Ramsey's Ditch to Leavitt Lake

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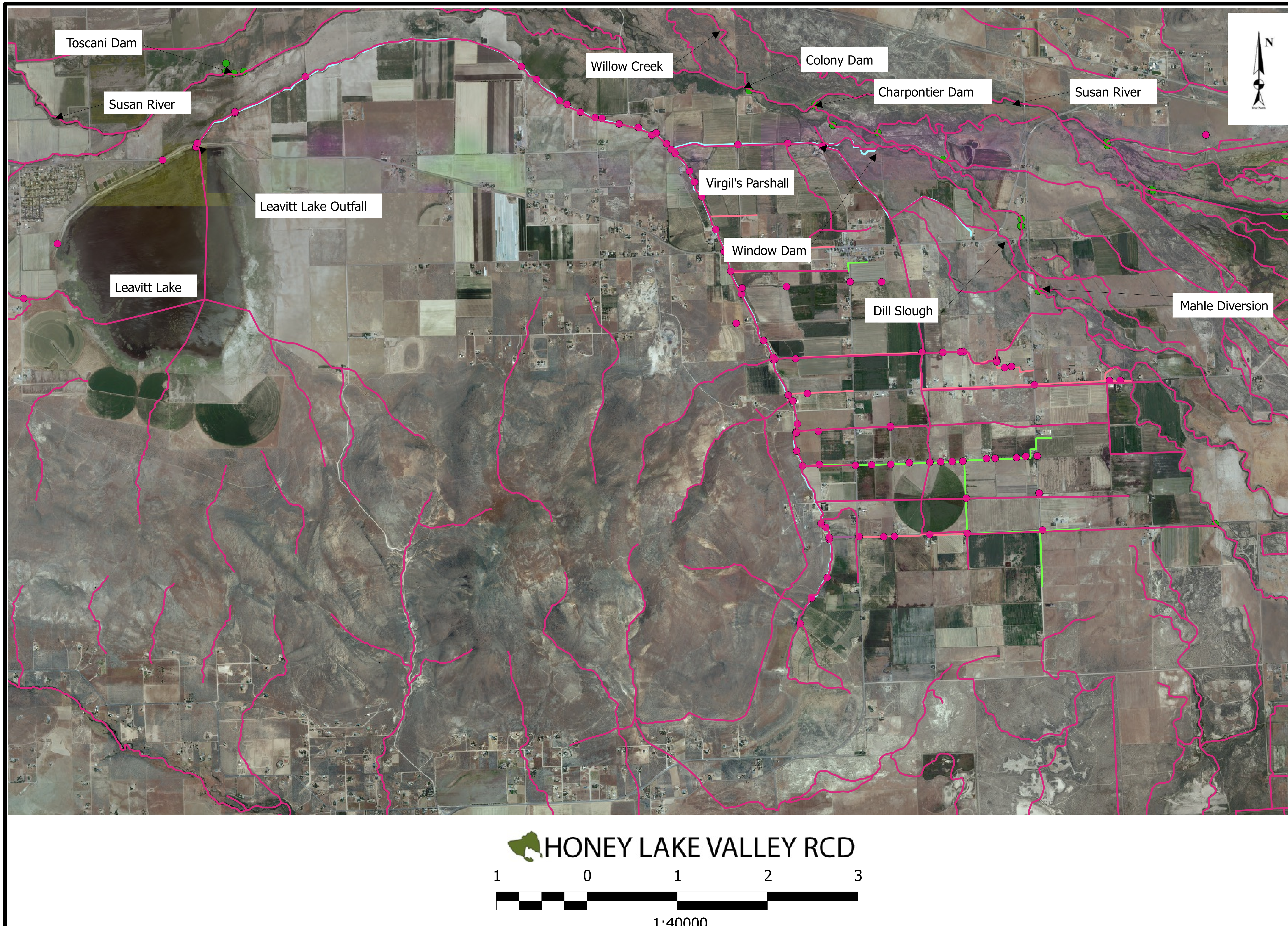
FIGURE 05 OF 12



Legend
Rivers & Creeks
HLVRCD Structures
LIC Structures
LIC Open Ditch - Unlined
LIC Open Ditch - Lined
LIC Distribution Canal
LIC Conveyance Pipe

Susan River and LIC Canal Network Leavitt Lake To Colony Dam

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FIGURE 06 OF 12

HONEY LAKE VALLEY RCD

1 0 1 2 3

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Legend

- Rivers & Creeks
- HLVRCD Structures
- LIC Structures
- LIC Open Ditch - Unlined
- LIC Open Ditch - Lined
- LIC Distribution Canal
- LIC Conveyance Pipe

Lower Susan River Colony Dam to Flemming Dam & DWF Diversions

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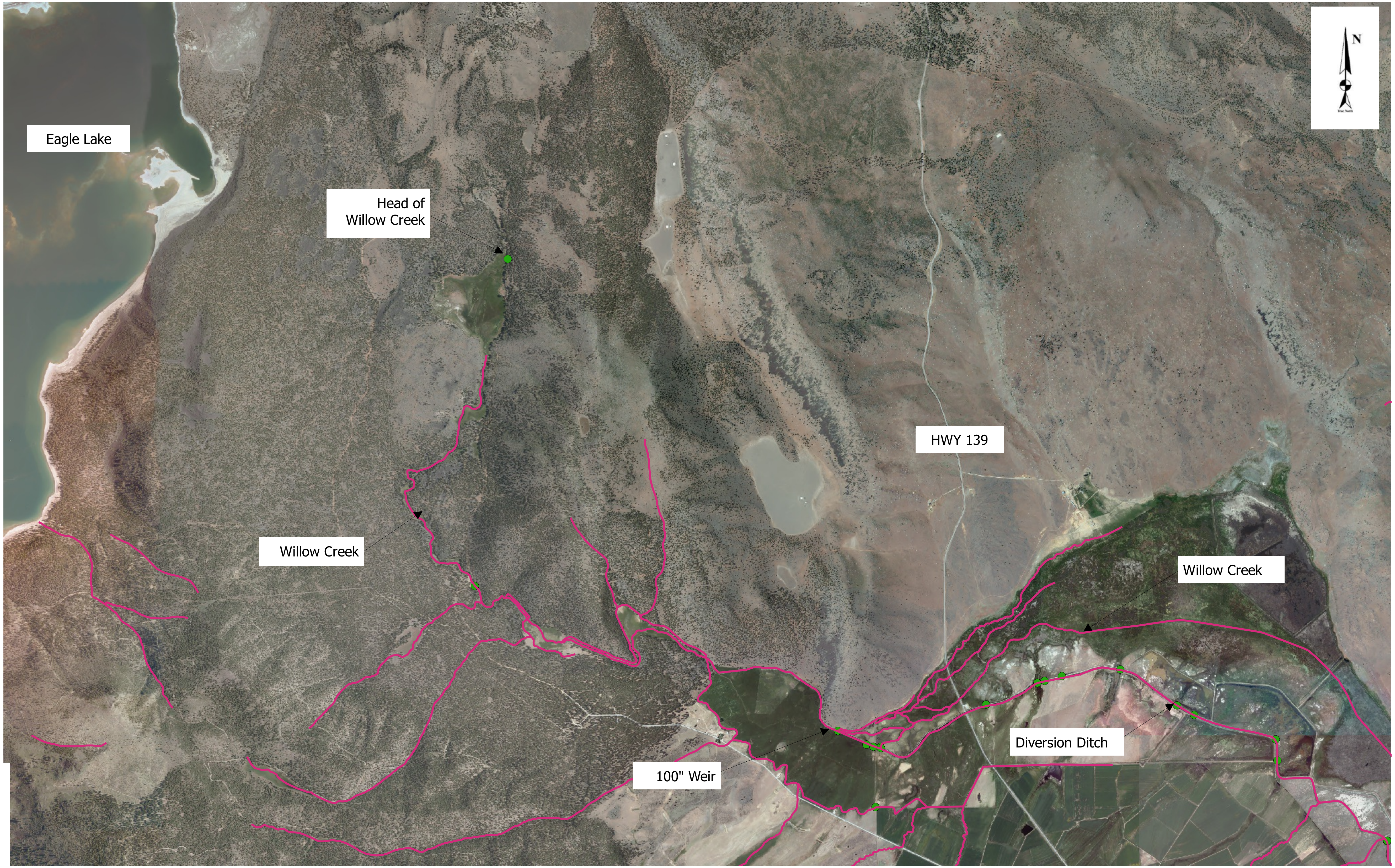
FIGURE 07 OF 12



HONEY LAKE VALLEY RCD

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Legend

- Rivers & Creeks
- HLVRCD Structures
- LIC Structures
- LIC Open Ditch - Unlined
- LIC Open Ditch - Lined
- LIC Distribution Canal
- LIC Conveyance Pipe

Upper Willow Creek

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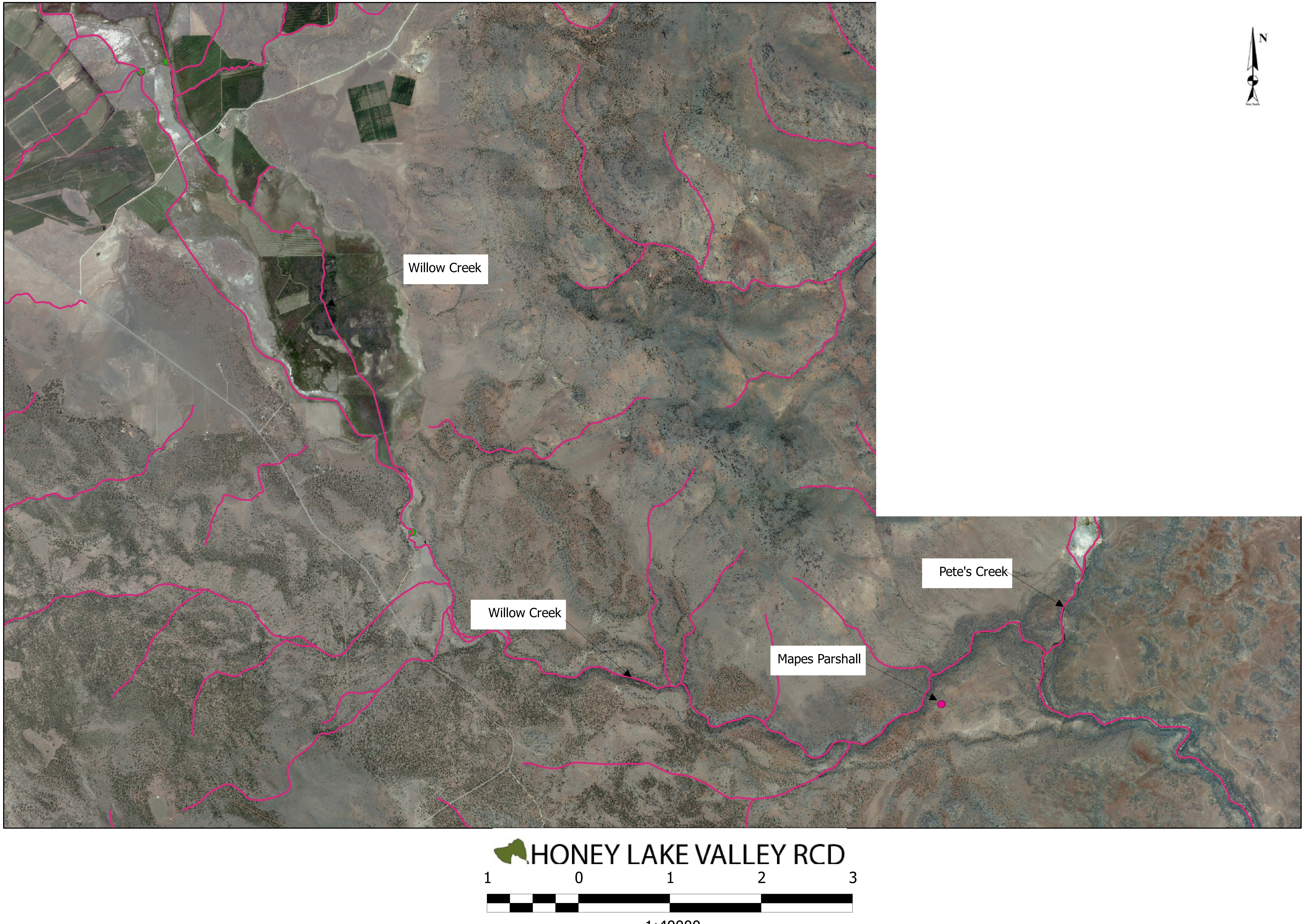
FIGURE 08 OF 12



Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

Middle Willow Creek

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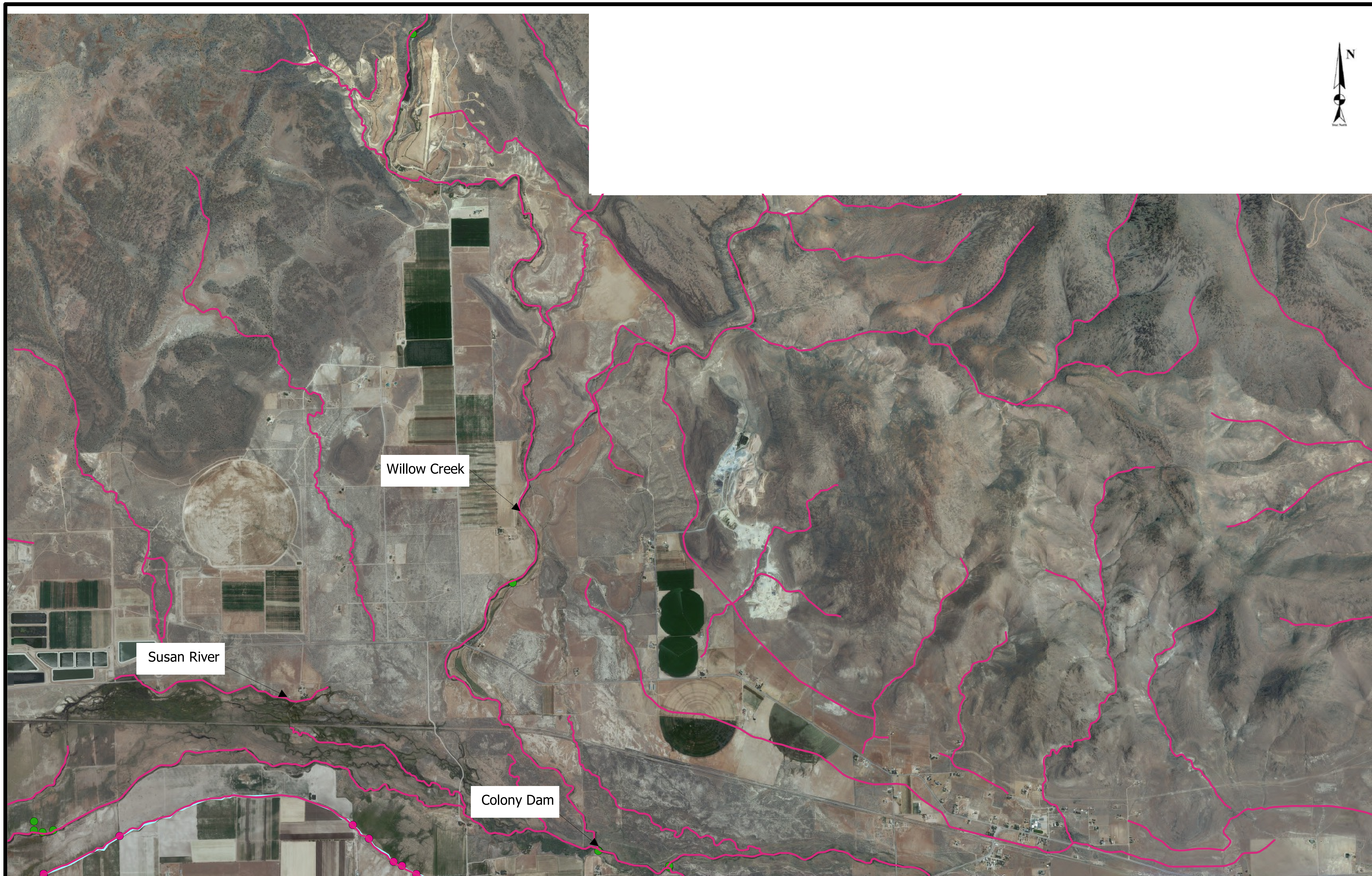

HONEY LAKE VALLEY RCD

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Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

Lower Willow Creek to Susan River

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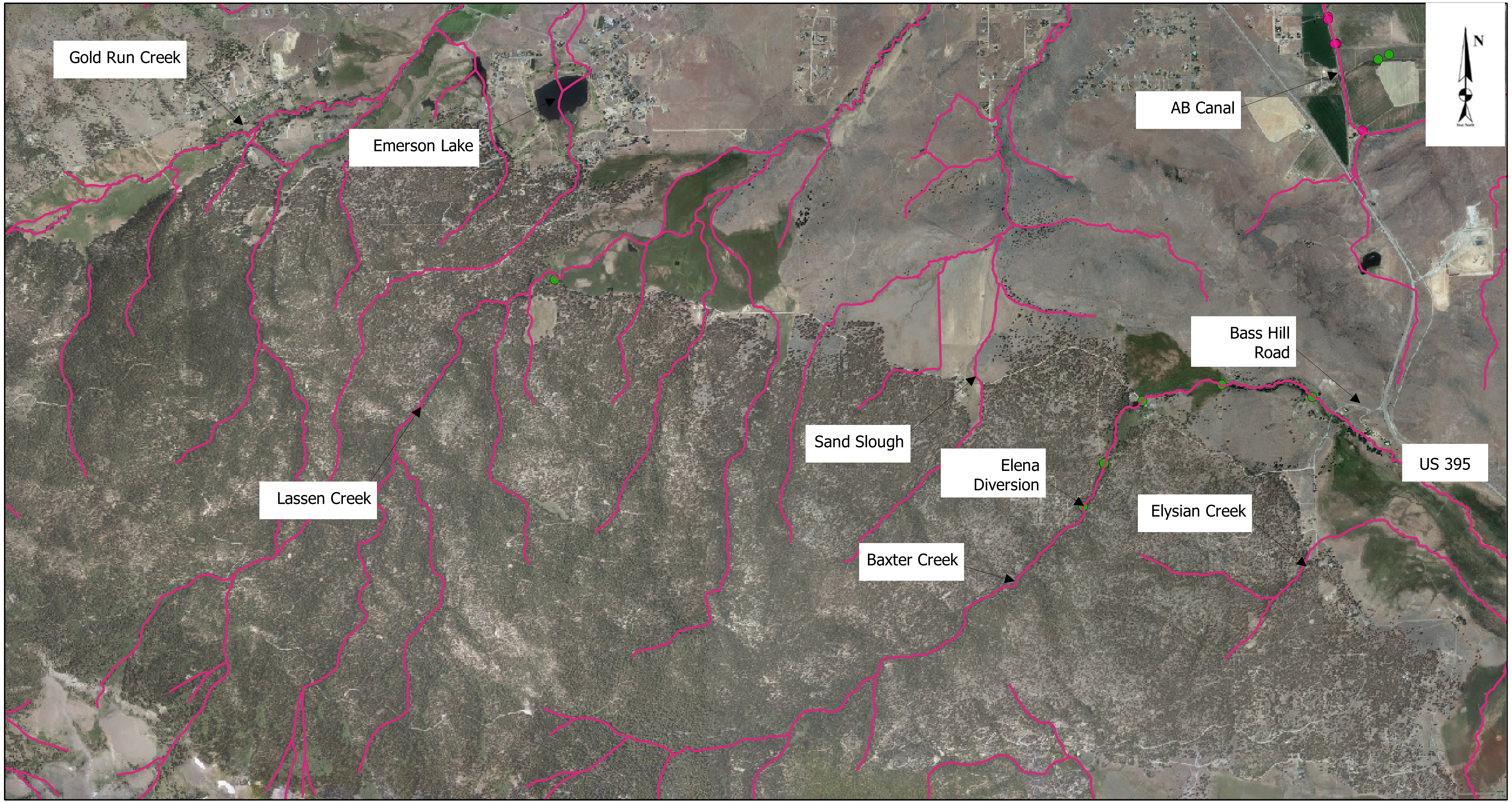
FIGURE 10 OF 12



Legend

- Rivers & Creeks
- HLVRCD Stuctures
- LIC Structures
- LIC Open Ditch - Unlined
- LIC Open Ditch - Lined
- LIC Distribution Canal
- LIC Conveyance Pipe

HONEY LAKE VALLEY RCD

1 0 1 2 3

1:40000

Upper Baxter Creek

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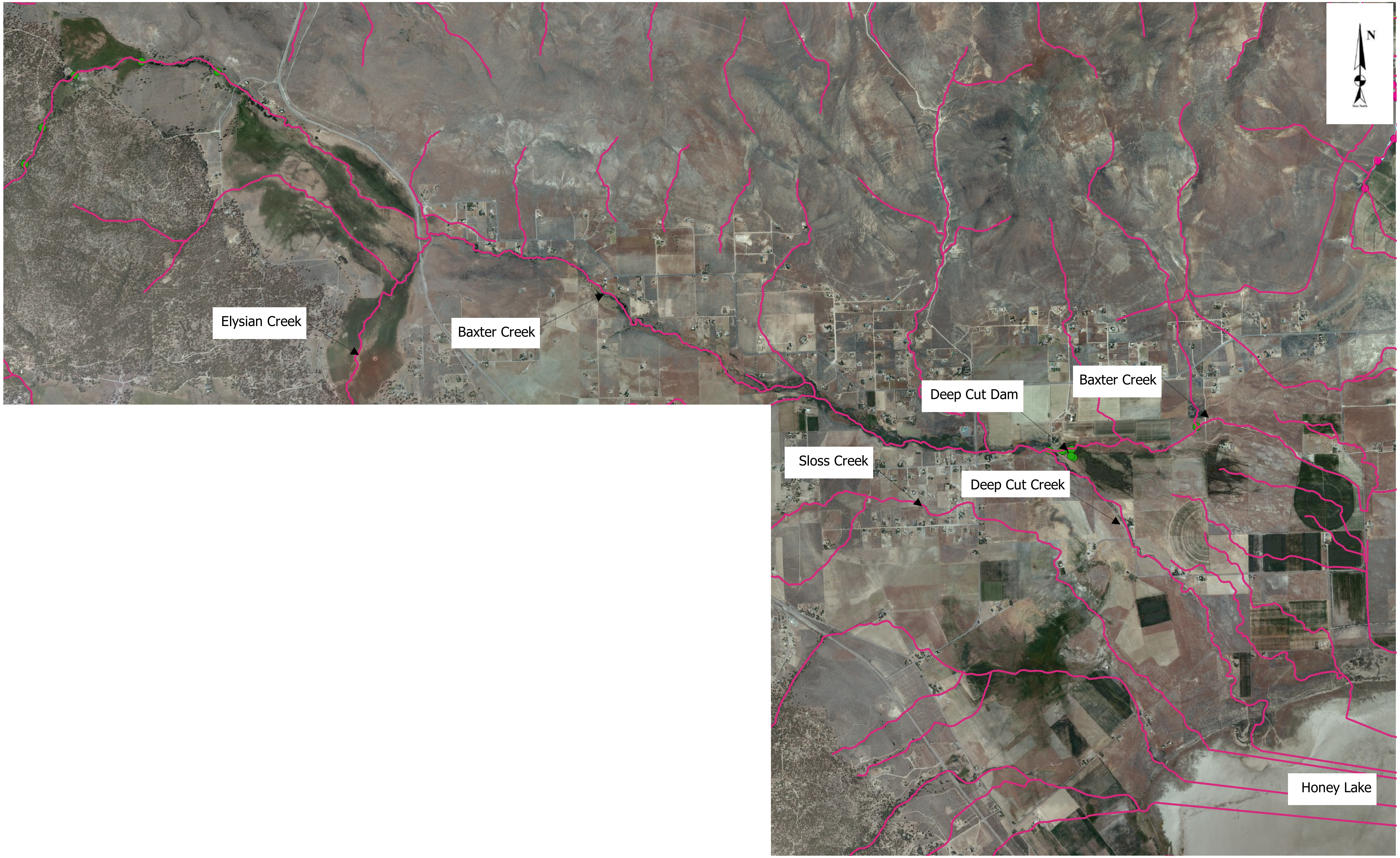

Legend

Rivers & Creeks

HLVRCD Structures

LIC Structures

LIC Open Ditch - Unlined

LIC Open Ditch - Lined

LIC Distribution Canal

LIC Conveyance Pipe

HONEY LAKE VALLEY RCD

1 0 1 2 3

1:40000

Lower Baxter Creek to Honey Lake

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FIGURE 12 OF 12

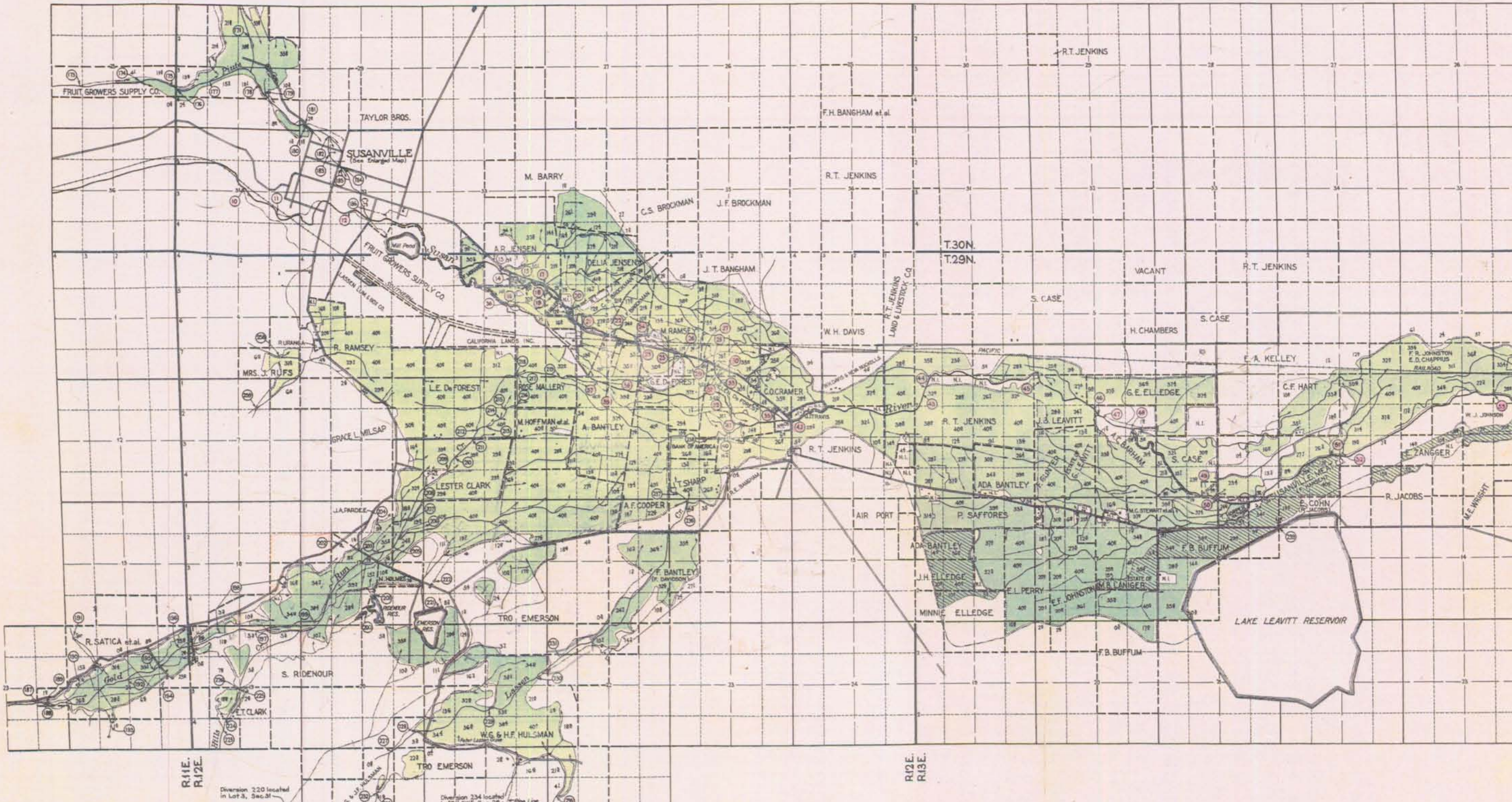
Appendix E
Susan River Decree Maps

SHEET NO. 1
SUSAN RIVER

137.5
878.8

SHEET NO. 2
SUSAN RIVER

SHEET NO. 3
SUSAN RIVER



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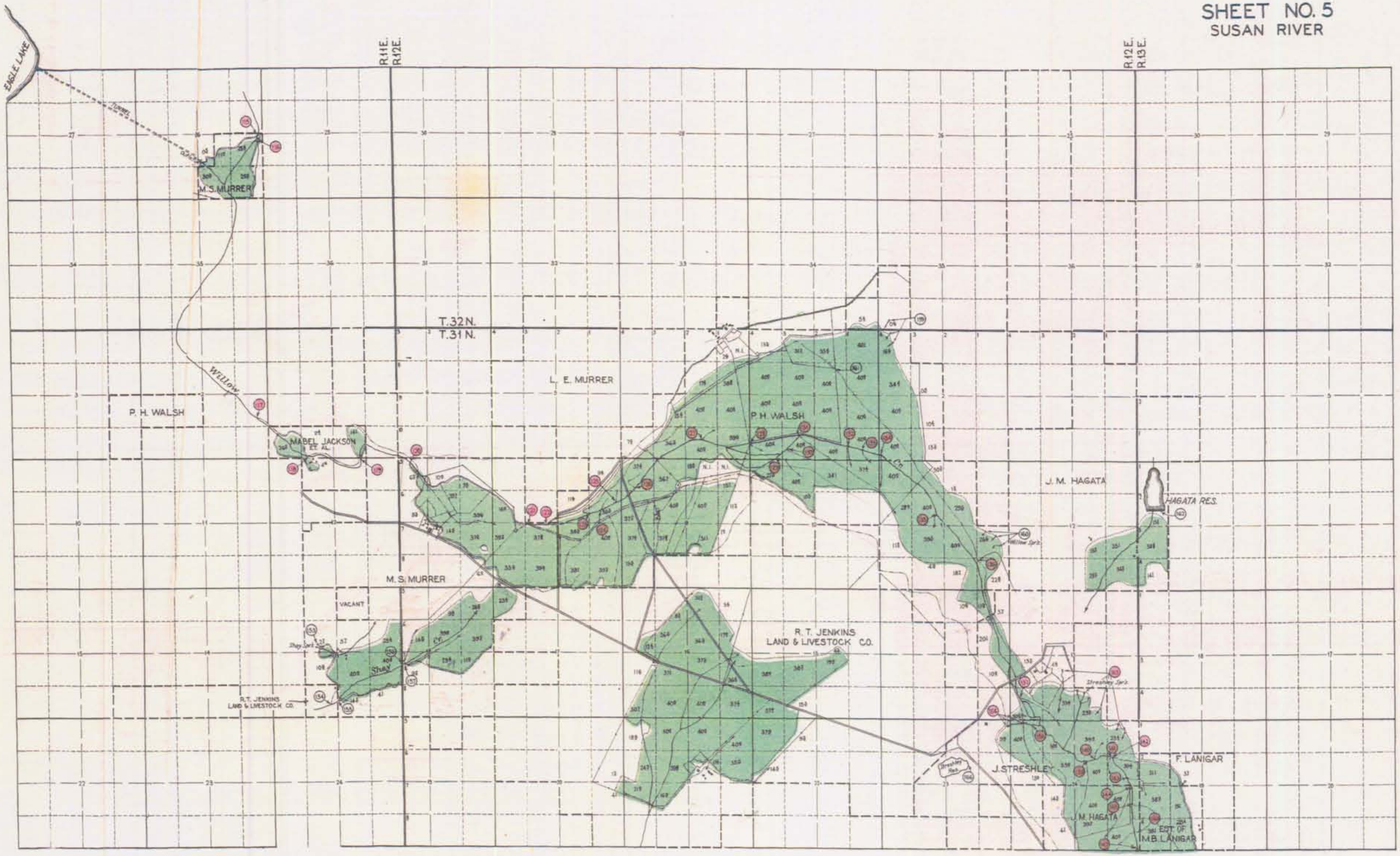
SUSAN RIVER

SHEET NO. 5
SUSAN RIVER



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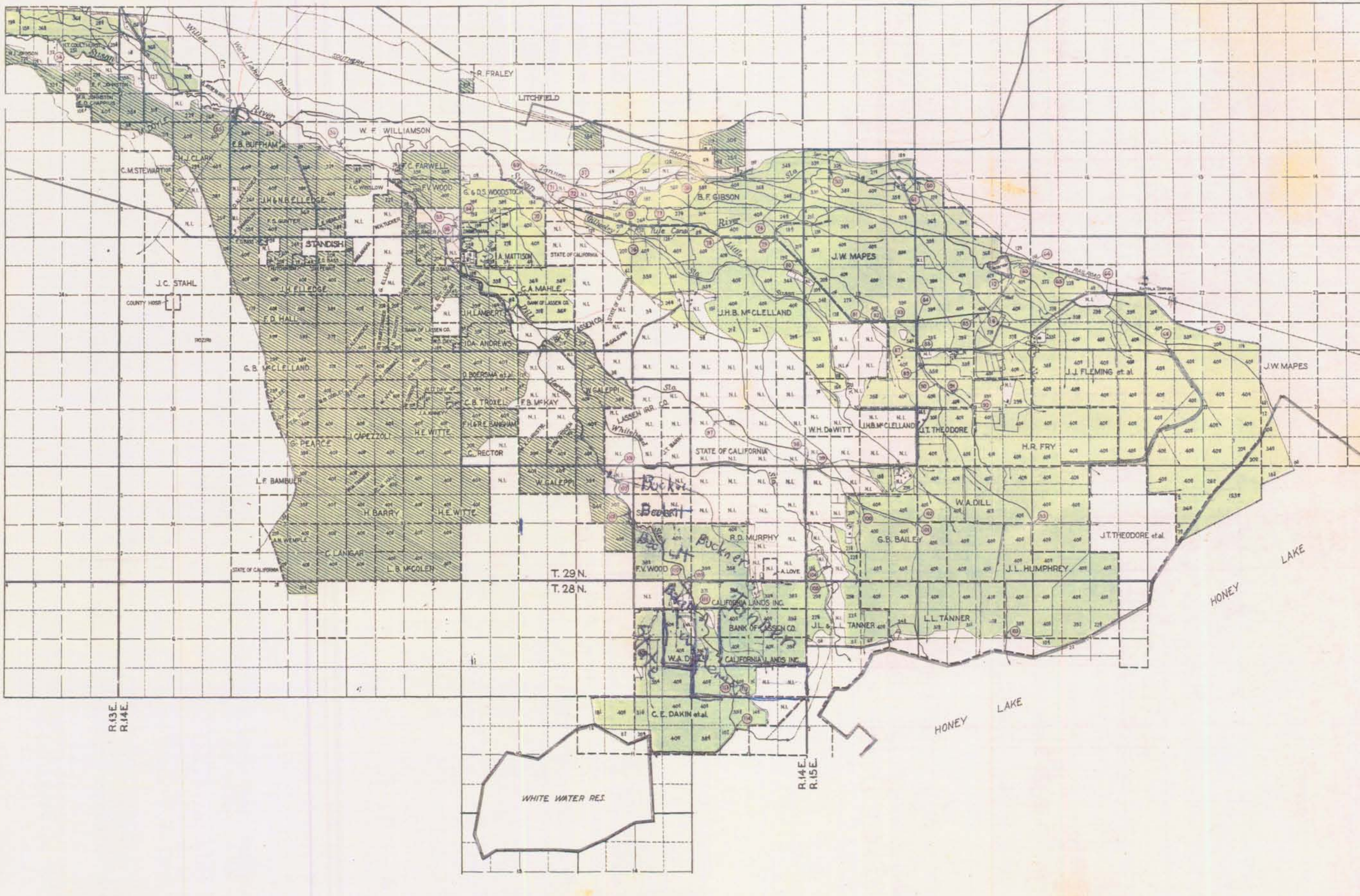
SUSAN RIVER



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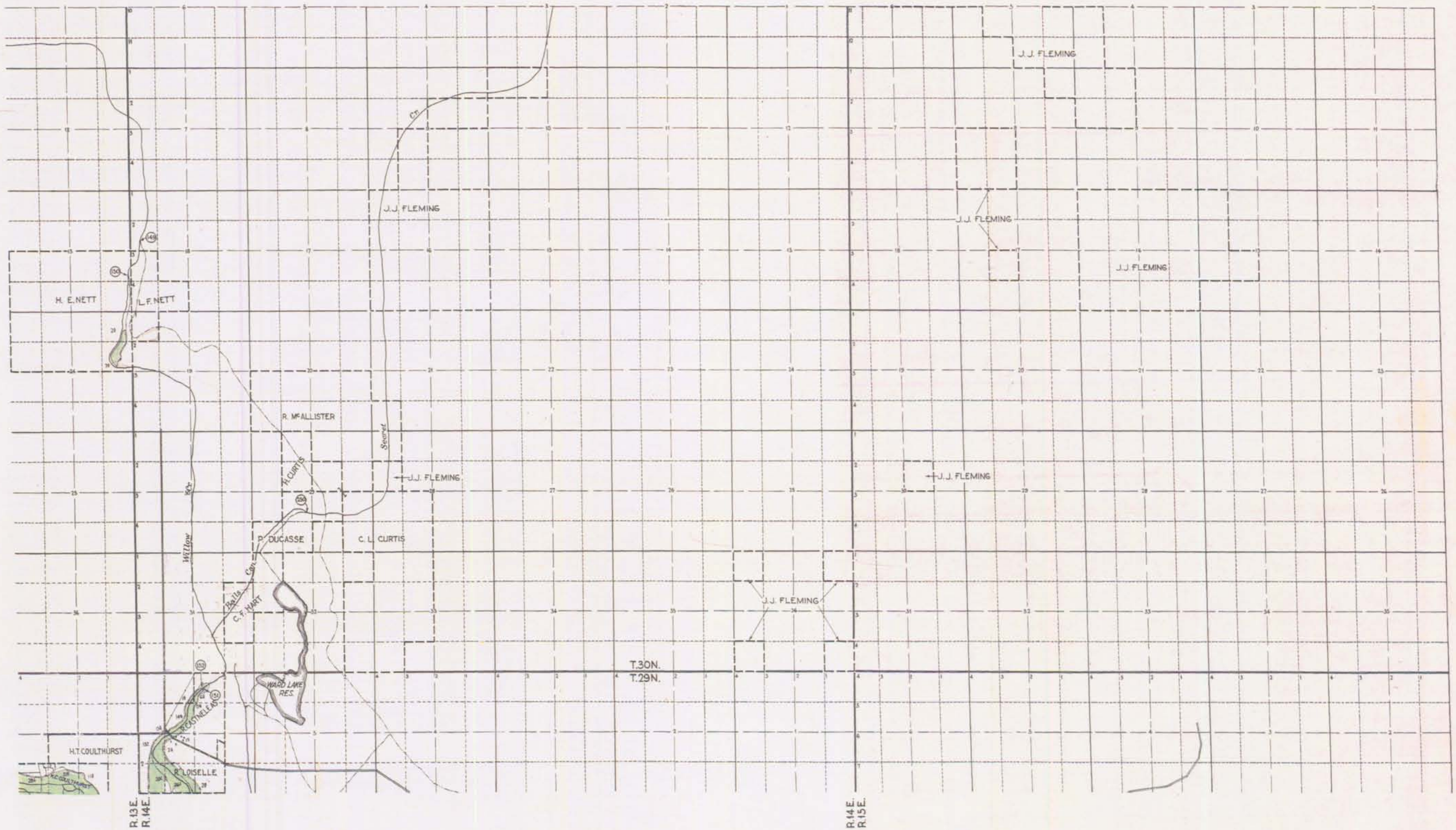

SHEET NO. 8
SUSAN RIVER