Lake Chelan Reclamation District

COMPREHENSIVE WATER CONSERVATION PLAN

Prepared By

RH2 ENGINEERS PLANNERS SCIENTISTS

LAKE CHELAN RECLAMATION DISTRICT MANSON, WA

Summer 2017

Certification

This Comprehensive Water Conservation Plan for Lake Chelan Reclamation District was prepared under the direction of the following registered professional engineers.

7/13/2017

7/13/2017

Prepared by RH2 Engineering, Inc.
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Chapter 1

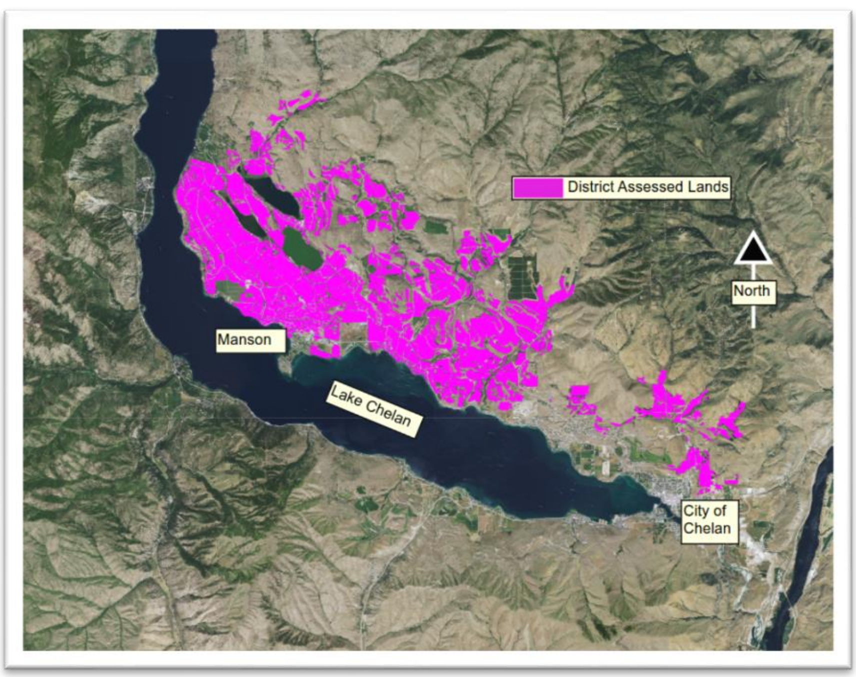
ORGANIZATION

1. Introduction

The Lake Chelan Reclamation District (District) is located in Chelan County, Washington. The District serves lands from the community of Manson to the City of Chelan on the north shore of Lake Chelan. The purpose of this Comprehensive Water Conservation Plan (Plan) is to comply with the Washington State Department of Ecology's (Ecology) and U.S. Bureau of Reclamation's (USBR) planning requirements, and to review the District's system for possible enhancements. This Plan is written to comply with Washington Administrative Code (WAC) 173-170-040 – Comprehensive Water Conservation Plan.

The District is authorized to operate, assess, and contract with the other governmental entities under Chapter 87.03 Revised Code of Washington (RCW) and its subsections. The location of the District's assessed lands is shown in **Figure 1-1**.

Figure 1-1 Vicinity Map



2. History

The possibilities of irrigated agriculture and speculative land sales in the Manson area were recognized by in the early 1900s. The Wapato Irrigation Company was incorporated in 1906 with the purpose of developing irrigation works for commercial uses, together with buying and selling adjacent lands.

Between 1906 and 1911, the Wapato Irrigation Company purchased 1,351 acres of land from the Wapato Allottee Indians and filed for water rights on 12 creeks and lakes. The Wapato Irrigation Company also hired engineers and constructed about 6 miles of main distribution canal from the reservoir now known as Wapato Lake.

On April 21, 1911, the assets of the Wapato Irrigation Company were purchased by the Lake Chelan Land Company. In June 1911, the Lake Chelan Land Company conveyed the water rights and irrigation works to the Lake Chelan Water Company to handle all matters pertaining to its construction and operation. The Lake Chelan Land Company could then confine its activities wholly to the acquisition and sale of irrigable lands.

By 1916 the two companies were both extended to the utmost financially. The Lake Chelan Irrigation District was formed in 1917 for the expressed purpose of acquiring the irrigation works form the Lake Chelan Water Company. The two organizations were unable to come to terms due to the bankruptcy litigation of the Lake Chelan Land Company. The Lake Chelan Irrigation District was subsequently dissolved in February of 1919.

The District began its organization in October 1919, and eventually acquired the assets of the Lake Chelan Water Company by deed. The District was adjudged organized on May 8, 1920, and encompassed approximately 6,860 acres, of which 4,359 were classed as irrigable. Approximately 1,198 of those acres were being irrigated at the time. The assets included a 14-mile collection system from Big Grade Creek to the Antilon Reservoir. The Antilon Reservoir had a storage capacity of 1,130 acre feet. Assets also included a partially completed distribution system and the Wapato Lake Reservoir.

During the years between 1920 and 1940 the District accumulated considerable debt to expand and complete the system. The District had to overcome periods of drought and the necessity to rebuild sections destroyed by fire. Heavy reliance was placed on Washington State's Reclamation Revolving Fund during these years, and at one point the debt reached approximately $500,000. Repayment began in the early 1940s and continued until 1961 when the final payment was made to the state.

In 1955, USBR was asked to investigate the expansion and rehabilitation of the District. Studies between 1956 and 1960 investigated options of rehabilitating the gravity collection and distribution systems, together with enlarging Antilon Lake to a capacity of 9,000 acre-feet. The expanded system would serve up to 5,770 acres as compared to the currently served 4,365 acres.

The application to be part of the Chief Joseph Dam irrigation project was authorized by Congress in 1966. New studies evaluated the feasibility of rebuilding the system through pumping and storage facilities from Lake Chelan. In June of 1969 the first appropriation for construction was approved by Congress for the pumping and storage facilities alternative, with the contract between the District and USBR signed in April of 1971. The irrigation system is owned by the USBR and the District is its operating agent. The total project cost for the system was $18,778,000, with completion occurring in 1975.

The District entered into a contract with USBR and Chelan County Public Utility District (PUD) No. 1 in 1974 to construct and operate electric power transmission facilities. The contract is for 50 years and expires in 2024. The contract and 1976 amendment are found in **Appendix C**.

The system includes 73 miles of pipeline in the distribution system, together with 10 miles of drains, 13 pumping plants, and 13 reservoirs. A total area of 6,336 acres can be contractually served by the irrigation system. Another 255.48 acres is currently served through the District's domestic water system.

Since the 1975 project, the system has performed well, though a few replacements and improvements have been needed. The following is a partial list of major system improvements that have been completed since 1975.

- 1991: Pumping Plant B – Added Pump No. B-8 (later renamed to B-5 to coincide with lead-lag operational sequencing) to increase capacity to 3,000 gallons per minute (gpm) (6.7 cfs).
- 1993: Replaced approximately 3 miles of 30-inch to 45-inch-diameter reinforced plastic mortar pipe with lined and coated steel pipe.
- 1993: Pumping Plant A – Replaced 200 hp Pump No. A-4 with a larger 500 hp pump to increase capacity. Pump is estimated to produce 6,000 gpm (13.4 cfs).
- 1995-2001: Repainted the interior and exterior of all reservoirs. Installed passive anodes in the reservoirs for corrosion control (inspection reports are included in **Appendices J and M**).
- 1997: Installed a remote telemetry control system.
- 2002-current: Replaced approximately half of customer meters.
- 2003-2006: Replaced all pump station transformers to eliminate the polychlorinated biphenyl (PCB) contamination risk.
- (Pre-2010, exact date unknown): Replaced two pneumatic control valves at Plant LC with swing check valves. Pneumatic valves have since been reinstalled due to water hammer concerns.
- 2010: Pumping Plant A – Replaced the Pump No. A-5 synchronous motor with an asynchronous style motor.
- 2011: Pumping Plant LC – Replaced Pump No. LC-6 due to wear and vibration.
- 2012-2014: Added butterfly valves on discharge of all Plant LC pumps.

3. Operational Policies and Procedures

The District endeavors to share equally the total water supply available to the approximately 6,336 acres served, except where limited physically by capacity or legally by contract. The distribution system was designed to deliver 6.9 gpm per acre at a minimum of 35 pounds per square inch (psi) to the high point of every tract, with not more than a 10-percent loss allowance for the on-farm distribution system.

The base allotment for each irrigable acre is 3 acre-feet per season. When water supplies are available, excess water may be obtained per the excess rate schedule. Excess rates are calculated to be a percentage of the annual operation and maintenance (O&M) charges on a per acre-inch basis, less the portion attributable to construction repayment.

- Excess rate one is 100 percent of this per acre-inch basis and applies to the first 6 acre inches above the base rate.
- Excess rate two is 120 percent of the per acre-inch basis and applies to usage above 42 acre inches.

Total water use is recorded by flow meters at each customer turnout. Instantaneous usage is not recorded but is monitored during periods when demand exceeds system capacity The District restricts water use to 8 gpm per acre and recommends that designers of all new private irrigation use the 8 gpm for sizing and operations. District water is to be used only upon lands classified as irrigable by the District. The LC and A systems are typically rationed to 10 gpm per acre during the same time period.

The complete Bylaws, Rules, and Regulations for the irrigation system are found in **Appendix A**.

4. Rate Policies and Procedures

The Board of Directors sets the annual assessment rate for the irrigation system in the manner prescribed by RCW 87.03.240 through RCW 87.03.260, together with generally accepted accounting practices for non-profit municipal corporations. The levies are set to provide income sufficient to cover debt service, insurance, overhead, power costs, salaries, and O&M costs, together with contributions toward construction, equipment, bonds, and emergency reserves. District policy sets assessments at 1.0 share (unit of benefit) per acre, with a minimum charge as determined by the Board of Directors.

The levies are set by the first Tuesday in November and, upon public notice, discussed at a Board of Equalization to hear and determine any objections to the levies and assessments. The assessment roll is then completed and the levies are implemented in assessment form due and payable by the following February 15th. Balance sheets for the last 5 years, and statements of income and expense for the past 5 years can be found in **Appendix E**. The State Auditor's current report can be found in **Appendix D**. Past and current assessment rates are found in **Chapter 7**.

Chapter 2

LAND BASE AND LAND USE

1. Land Base

The Lake Chelan Reclamation District (District) has a variety of soils, slopes and arable lands throughout the boundaries of the District. The U.S. Bureau of Reclamation (USBR) completed an extensive survey at the time the new system was being planned in the 1960s to delineate the irrigable lands. Classifications of 1, 2, 3. or 6I were given to irrigable lands, with the 6I designation given to those arable lands who choose not to take a water right or are serviced by a special contract. Class 6I lands designate irrigable lands for which the District has an obligation to provide water, but are not assessed due to contracts previously entered into with the United States. More information regarding the Class 6I lands can be found in the 1971 contract in **Appendix C**.

All lands classified as 1 through 3 are assessed. Minor changes as allowed for by the Bylaws, and Rules and Regulations, and consistent with the District's repayment contract with USBR, have occurred over the years. Less than 5 percent of irrigable lands are not irrigated on an annual basis.

Special contract lands fall primarily into three categories. The first category is Indian Tract lands. A water agreement between the Bureau of Indian Affairs on behalf of Indian landholders and the Wapato Irrigation Company guaranteed water delivery at limited rates to those lands in exchange for purchase rights, easements, and rights-of-way.

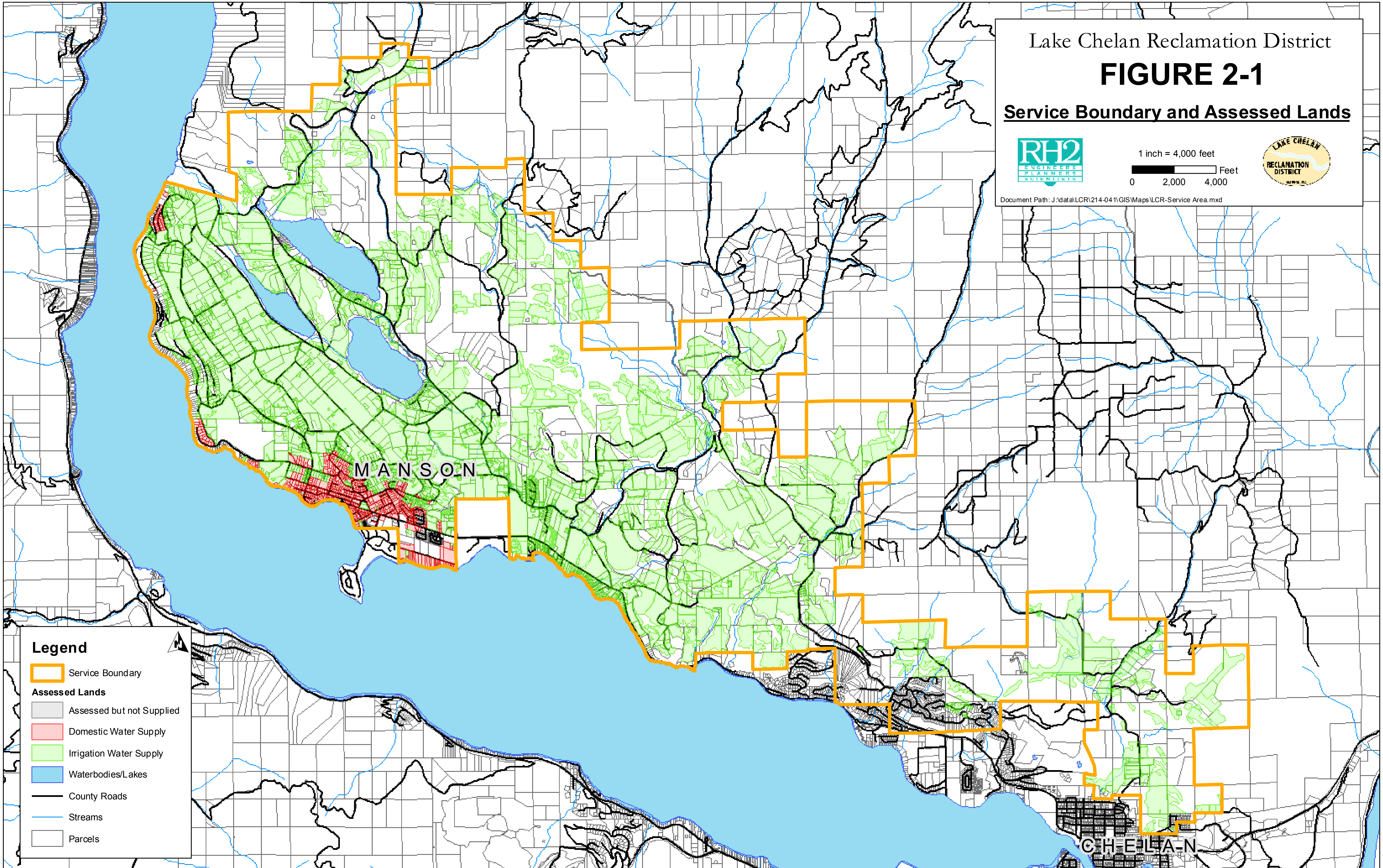
The second category of special contract lands is water right lands associated with a 1932 court adjudication on Joe Creek lands. The Joe Creek lands are guaranteed special water deliveries at limited assessments in exchange for releasing their individual water rights to Joe Creek.

The third category is the so-called Laycock lands. The Laycock lands are provided irrigation water through the domestic system at defined rates to satisfy special water right claims these lands obtained prior to the formation of the District.

The following is a summary of the District's assessed lands.

- 6,225 acres plus Joe Creek lands: Original USBR contract.
- 111 acres: Added after USBR re-evaluated the system.
- 6,336 acres: Current assessment limit.
- 255.48 acres: Assessed but supplied by domestic water system.
- 2,201: Total number of parcels with assessments.

The District's service boundary and assessed lands are shown on **Figure 2-1**. The lands on Figure 2-1 designated as "Assessed but not supplied" are properties that use District water, but have their own private supply system.


Lake Chelan Reclamation District
FIGURE 2-1
Service Boundary and Assessed Lands
RH2 ENGINEERS PLANNERS SCIENTISTS
1 inch = 4,000 feet
Feet
0
2,000
4,000
LAKE CHELAN RECLAMATION DISTRICT
Document Path: J:\data\LCR\214-041\GIS\Maps\LCR-Service Area.mxd
MANSON
CHELAN
Legend
Service Boundary
Assessed Lands
Assessed but not Supplied
Domestic Water Supply
Irrigation Water Supply
Waterbodies/Lakes
County Roads
Streams
Parcels

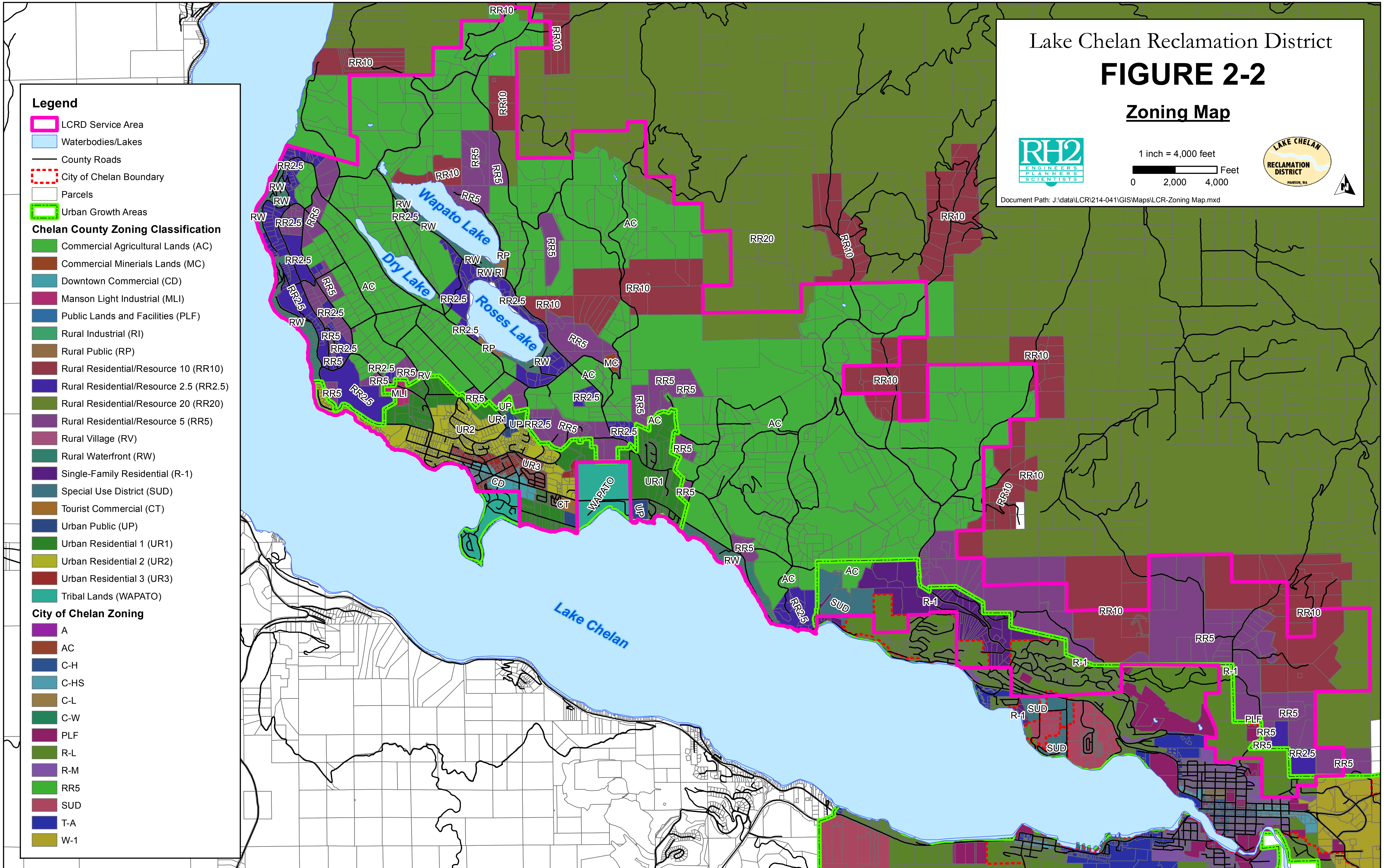
2. Land Use

The District's service area covers approximately 23 square miles (14,800 acres) and coincides with the water rights place of use. Only a portion of land within the service area boundary is served and assessed.

The District's boundary encompasses many land use designations, though most land within the District is zoned agricultural and low density residential. The acreage within the District's service area boundary as categorized by land use zoning is listed in **Table 2-1**, and shown on **Figure 2-2**.

Table 2-1 Zoning Within District Boundary

Jurisdiction	Zoning	Description	Acres
Chelan County	AC	Commercial Agricultural Lands	7,213
Manson	CD	Downtown Commercial	65
Manson	CT	Tourist Commercial	20
Chelan County	MC	Commercial Minerals Lands	8
Manson	MLI	Manson Light Industrial	24
City of Chelan	PLF	Public Lands and Facilities	21
City of Chelan	R-1	Single-family Residential	344
Chelan County	RI	Rural Industrial	3
City of Chelan	R-L	Low Density Residential	1,116
City of Chelan	R-M	Medium Density Residential	2
Chelan County	RP	Rural Public	19
Chelan County	RR10	Rural Residential/Resource 10	1,291
Chelan County	RR2.5	Rural Residential/Resource 2.5	816
Chelan County	RR20	Rural Residential/Resource 20	581
Chelan County	RR5	Rural Residential/Resource 5	2,082
Chelan County	RV	Rural Village	1
Chelan County	RW	Rural Waterfront	251
City of Chelan	SUD	Special Use District	103
City of Chelan	T-A	Tourist Accommodation	3
Manson	UP	Urban Public	55
Manson	UR1	Urban Residential 1	497
Manson	UR2	Urban Residential 2	381
Manson	UR3	Urban Residential 3	102
Chelan County	WAPATO	Tribal Lands - Not Zoned	3
		Total Agricultural Zoning	11,167
		Total Residential Zoning	3,509
		Total Other Zoning	324


Lake Chelan Reclamation District
FIGURE 2-2
Zoning Map
RH2 ENGINEERS PLANNERS SCIENTISTS
1 inch = 4,000 feet
0 2,000 4,000 Feet
LAKE CHELAN RECLAMATION DISTRICT MANSON, WA
Document Path: J:\data\LCR\214-041\GIS\Maps\LCR-Zoning Map.mxd
Legend
LCRD Service Area
Waterbodies/Lakes
County Roads
City of Chelan Boundary
Parcels
Urban Growth Areas
Chelan County Zoning Classification
Commercial Agricultural Lands (AC)
Commercial Minerials Lands (MC)
Downtown Commercial (CD)
Manson Light Industrial (MLI)
Public Lands and Facilities (PLF)
Rural Industrial (RI)
Rural Public (RP)
Rural Residential/Resource 10 (RR10)
Rural Residential/Resource 2.5 (RR2.5)
Rural Residential/Resource 20 (RR20)
Rural Residential/Resource 5 (RR5)
Rural Village (RV)
Rural Waterfront (RW)
Single-Family Residential (R-1)
Special Use District (SUD)
Tourist Commercial (CT)
Urban Public (UP)
Urban Residential 1 (UR1)
Urban Residential 2 (UR2)
Urban Residential 3 (UR3)
Tribal Lands (WAPATO)
City of Chelan Zoning
A
AC
C-H
C-HS
C-L
C-W
PLF
R-L
R-M
RR5
SUD
T-A
W-1
Wapato Lake
Dry Lake
Roses Lake
Lake Chelan

Manson is an unincorporated community, with public roads and land use planning managed by Chelan County (County). The County most recently amended its *Comprehensive Plan* in 2015. The District's service area falls mainly within the Manson Subarea, which is covered in Appendix G of the County's *Comprehensive Plan*. A smaller portion falls within the City of Chelan planning area. The District also falls within the Chelan Regional Planning area described in Appendix H of the County's *Comprehensive Plan*.

The long-range land use plan is to expand the urban growth area (UGA) along the State Route (SR) 150 corridor towards the City of Chelan. The area described in the City of Chelan's *2012 Lower Lake Chelan Basin Regional Strategic Action Plan* for potential UGA expansion includes approximately 600 acres of assessed irrigated land currently served by the District. However, the UGA has not changed from its initial layout and, currently there is no proposed schedule to update the UGA.

3. Population

The *Comprehensive Plan* states that permanent populations have increased in the Lower Lake Chelan basin at an annual rate of about 1.5 percent per year since the year 2000. However, the permanent population figures do not reflect the large seasonal fluctuations experienced in the area. These seasonal fluctuations are due to changes in the farm labor force, recreational activities, summer homes, tourism, and the living patterns of retired persons. Estimates are that 30 percent of housing is seasonal.

An UGA was developed for Manson during the County's 2008 Planning efforts. In 2008, the County's *Comprehensive Plan* assumed that population will grow at an average of 1.5 percent per year, with 60 percent of the growth within the UGA and 40 percent in the rural areas. The population is expected to grow slowly outwards, with inevitable conversion of orchards to housing and other uses. The regional planning preference is to maximize infill in the existing urban areas and preserve agricultural lands. The UGA is shown on **Figure 2-2**.

In 2015, the County and local planning agencies updated the population forecasts using the 2012 Office of Financial Management projections. The 2015 forecasted growth rates are significantly lower than prior projections. Manson's forecast is 1.2 percent growth within the UGA through 2020, dropping steadily after that to 0.6 percent by the year 2040. This translates to a population increase from 2,064 persons in 2015 to 2,584 persons by 2040. Assuming low density residential development will be the primary use, an estimated 100 to 200 acres could be converted from agricultural to residential use by 2040.

4. Soil Classifications

The soils on irrigated lands fall mainly under the Antilon and Chelan categories, which are sandy/silty loams well suited for agriculture. The soils originated from volcanic ash, pumice, and loess over glacial till. Practical boundaries to farming are generally due to steep slopes bordering natural drainage channels, exposed rock, and rock with little soil cover. See **Appendix G** for soil mapping and farmland ratings that were obtained from the Natural Resources Conservation Service (NRCS).

The irrigable characteristics shown in **Table 2-2** are identified in the State of Washington Irrigation Guide (WIG) for these soils. The column for % of Land includes all land within the District's service area, not just the irrigable land.

Table 2-2 – NRCS Soil Descriptions

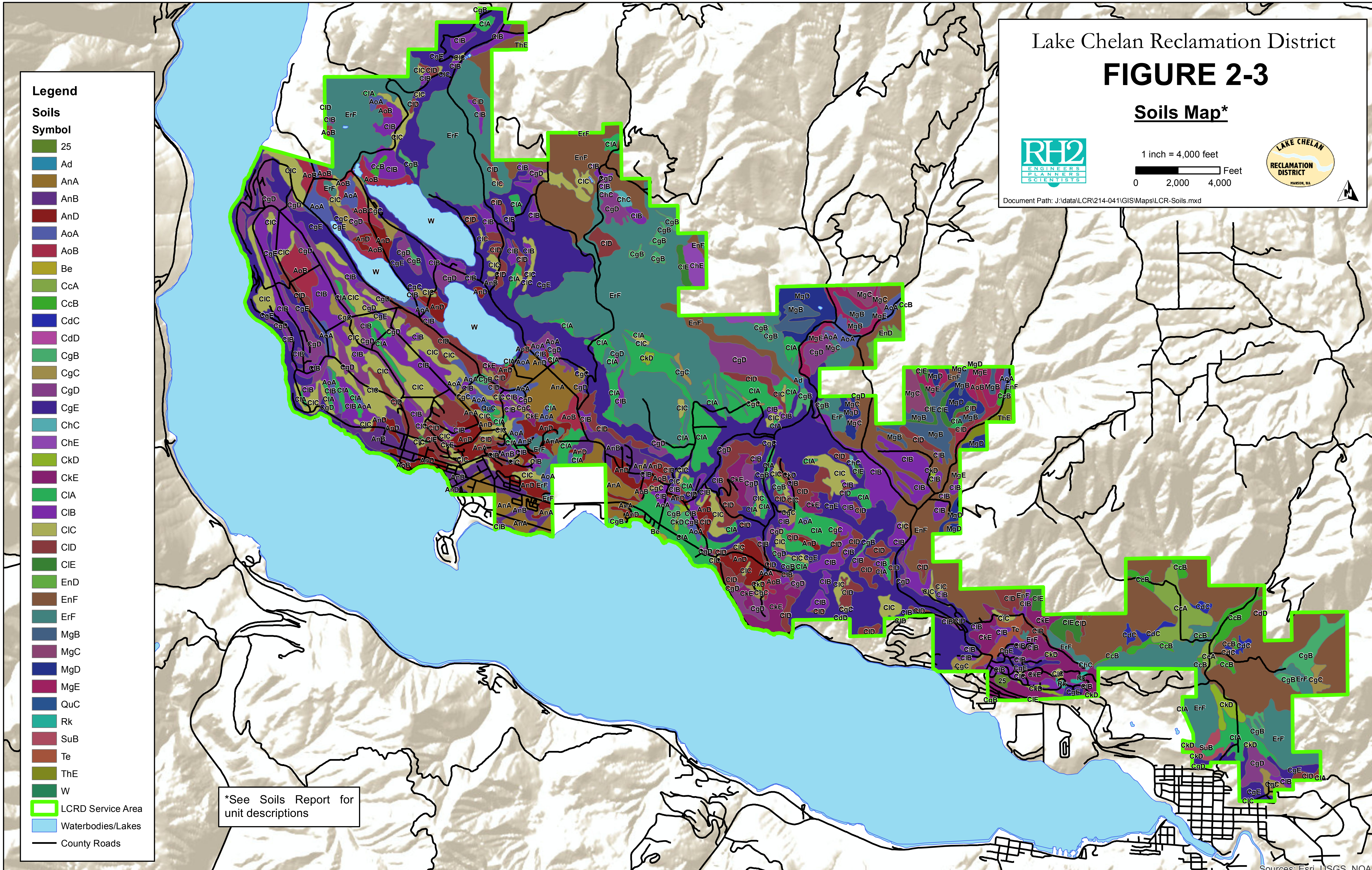
Type (Code)	% of Land	Available Water Capacity at 2-foot Depth	Maximum Sprinkler Application Rate	Critical Erosion Index [1]
Antilon gravelly sandy loam (An_)	12%	0.13 in/in	0.40 in/hr	0.45
Chelan gravelly sandy loam (Cg_)	24%	0.18 in/in	0.30 to 0.40 in/hr	0.75
Chelan bouldery sandy loam (Ck_)	3%	0.18 in/in	0.30 to 0.40 in/hr	0.75
Chelan gravelly sandy loam, pumiceous (Cl_)	27%	0.18 in/in	0.30 to 0.40 in/hr	0.75
Entiat sandy loam (En_)	13%	0.07 in/in	0.60 in/hr	7.84
Entiat rock outcrop (Er_)	17%	n/a	n/a	n/a
Margerum gravelly silt (Mg_)	4%	0.15 in/in	0.50 in/hr	1.57

[1] Soils with Critical Erosion Index less than 50 are appropriate for high-capacity sprinkler irrigation.

Soil mapping is shown graphically on **Figure 2-3**.

5. Infrastructure and Services

Public roads in the District's service area are owned and maintained by the County and the Washington State Department of Transportation. Chelan County Fire District No. 5 provides emergency services for most of the District's service area via fire stations located at 250 West Manson Boulevard and 2010 Wapato Lake Road. Domestic water is provided by the District, with a few small Group B systems interspersed. Sanitary sewer is provided by the District, with septic systems in areas the District does not serve. Electrical power to the District's facilities is provided primarily by the Bonneville Power Administration. Electrical power for other uses is provided by Chelan County Public Utility District No. 1.



Lake Chelan Reclamation District

FIGURE 2-3

Soils Map*

Chapter 3

WATER SUPPLY, USE, AND RIGHTS

1. Water Rights / Claims

The majority of water rights for the Lake Chelan Reclamation District (District) come directly from Lake Chelan. Fifteen certificates for the Lake Chelan pumping plant were converted through changes in point of delivery from the old irrigation system. One certificate (S4-01345C) was added to equalize the rights to the actual diversion capability and acres served through the District's irrigation system.

The District operates a totally separate Group A water system for potable and irrigation uses. Some irrigation water rights are delivered through the domestic water system from either the Manson intake or the Lakeshore intake. Two certificates and two permits quantify the water rights and place of use for irrigation through the domestic (municipal) system.

The District also claims all water diversion rights out of Joe Creek and the Wapato, Roses, and Dry Lakes. Court Decree 9221, issued by Judge W.O. Parr in the State of Washington versus Lake Chelan Reclamation District, clearly defined water rights between all parties. Subsequent agreements and quit claim deeds between the District and Stevens, Venneberg, and Overbay, turned over all water rights to the District.

Wapato Lake is a 9,500 acre-foot storage reservoir from the old system that collects all Joe Creek waters. Roses Lake and Dry Lake are similar parts of the Joe Creek drainage that are also recharged by drainage and seepage water from adjacent lands. **Table 3-1** summarizes the water right certificates and permits on Lake Chelan.

Table 3-1 – Water Rights

Cert #	Priority	Qi (cfs)	Qa ac-ft	Acres	Point of Diversion	Purpose	Type
Irrigation System							
301	1906	18.50	3,984.5	1,171.9	Plant LC	Irrigation	Certificate
303	1907	3.74	798.0	234.7	Plant LC	Irrigation	Certificate
305	1912	1.82	399.0	117.4	Plant LC	Irrigation	Certificate
306	1906	0.08	16.8	5.0	Plant LC	Irrigation	Certificate
308	1907	3.74	798.0	234.7	Plant LC	Irrigation	Certificate
309	1908	0.20	42.8	12.6	Plant LC	Irrigation	Certificate
310	1908	3.74	798.0	234.7	Plant LC	Irrigation	Certificate
311	1912	1.82	399.0	117.4	Plant LC	Irrigation	Certificate
312	1906	0.18	39.9	11.8	Plant LC	Irrigation	Certificate
314	1921	0.93	199.5	58.9	Plant LC	Irrigation	Certificate
316	1909	4.63	997.5	293.4	Plant LC	Irrigation	Certificate
317	1909	4.63	997.5	293.4	Plant LC	Irrigation	Certificate
318	1909	4.63	997.5	293.4	Plant LC	Irrigation	Certificate
212	1927	15.78	2,728.0	1,000.0	Plant LC	Irrigation	Certificate
3408	1945	4.42	952.0	280.0	Plant LC	Irrigation	Certificate
S4-01345C	1969	37.86	8,240.0	2,240.7	Plant LC	Irrigation	Certificate
		106.70	**22,388.0**	**6,600.0**	**Total**		
Domestic Water System							
213	1927	1.78	*		Manson Station	Municipal	Certificate
S4-27077C	1980	4.90	672.0		Manson Station	Municipal	Certificate
S4-30333P	1990	4.00	1,000.0		Manson Station	Municipal	Permit
S4-30334P	1990	3.25	1,000.0		Manson Station	Municipal	Permit
		13.93	**2,672.0**		**Total**		

* Combined with S4-27077C for a total of 672 acre feet.
Qi = Maximum instantaneous withdrawal.
cfs = Cubic feet per second.
Qa = Maximum average annual withdrawal.
Ac-ft = Acre feet.

It is the District's opinion that the water rights are additive with the ability to serve 6,600 acres. Currently, 6,336 acres are assessed, leaving 264 acres for future expansion.

In December 2015, the District submitted an application for additional water rights to the Washington State Department of Ecology (Ecology). This request is for an additional 600 acres of irrigation within the existing District boundary. The goal of the application is to expand the irrigated acres from the existing authorized water right limit of 6,600 acres up to 7,200 acres. This application is intended to allow for infill of ground that was previously considered non-irrigable, but with the change in crops grown and irrigation methods could now be irrigated. The application requests 10.7 cubic feet per second (cfs) and 2,040 acre-feet per year (afy) (at 3.4 acre-feet per acre duty) for the use of water on 600 acres for irrigation, frost protection, and heat protection. The proposed period of use is March

15th through October 31st, which is consistent with the District's other irrigation rights. The proposed points of diversion from Lake Chelan under this application are the LC Intake, Lakeshore Intake, Manson Intake, and a different possible future location named the Marker Intake.

The District submitted this application in the event that additional water is available, or might be made available, from Chelan County Public Utility District No. 1's (PUD) power generation water right (Surface Water Certificate No. 319) for additional consumptive uses in the Lake Chelan Watershed. If so, Ecology might start a coordinated cost reimbursement process under Revised Code of Washington (RCW) 90.03.265(3) to get as many of the applications processed as possible.

1971 USBR Contract

The 1971 contract between the U.S. Bureau of Reclamation (USBR) and the District stated the irrigation system was designed to supply "approximately 100 cfs" or 6.9 gallons per minute (gpm) per acre for 6,225 acres, plus "Indian" lands and Joe Creek releases (**Appendix C**). Delivery pressure was established as 35 pounds per square inch (psi) to the high point of the irrigable land, assuming no more than 10 percent friction loss in the on-farm delivery systems. The Joe Creek land is not described in the contract other than stating delivery is not to exceed 30 acre-feet annually. Subsequent agreements have modified the served acres and addressed power delivery contracts.

2. Water Source

Lake Chelan Storage

Lake Chelan storage content and lake levels are controlled by Chelan County PUD No. 1. The outflow from the lake is the Chelan River, where the water is either diverted into penstocks for the generation of power or spilled into Chelan Gorge when it is warranted by the lake level or flood potential. Lake levels by power contract fluctuate from a minimum elevation of 1,079 feet MSL in April, up to a full elevation of 1,100 feet mean sea level (MSL) in July and August. Reservoir operations are designed to optimize the recreational opportunities in the summer. Total lake volume is estimated at 677,000 acre-feet.

The District's pumping plants are designed to operate efficiently at the minimum lake elevations, but are enhanced by the full pool during the peak use months. District irrigation diversion rights predate all power diversion rights in Lake Chelan.

3. Water Use

The new portion of the District system is a totally enclosed pressure delivery system. Essentially, all water diverted from the lake is used for on-farm irrigation purposes. The only conveyance losses in the system are due to pipeline breaks, small leaks, and system drainage at the end of the season. **Table 3-2** contains a tabulation of actual quantities of water diverted annually and by month in acre-feet for 2008 through 2015.

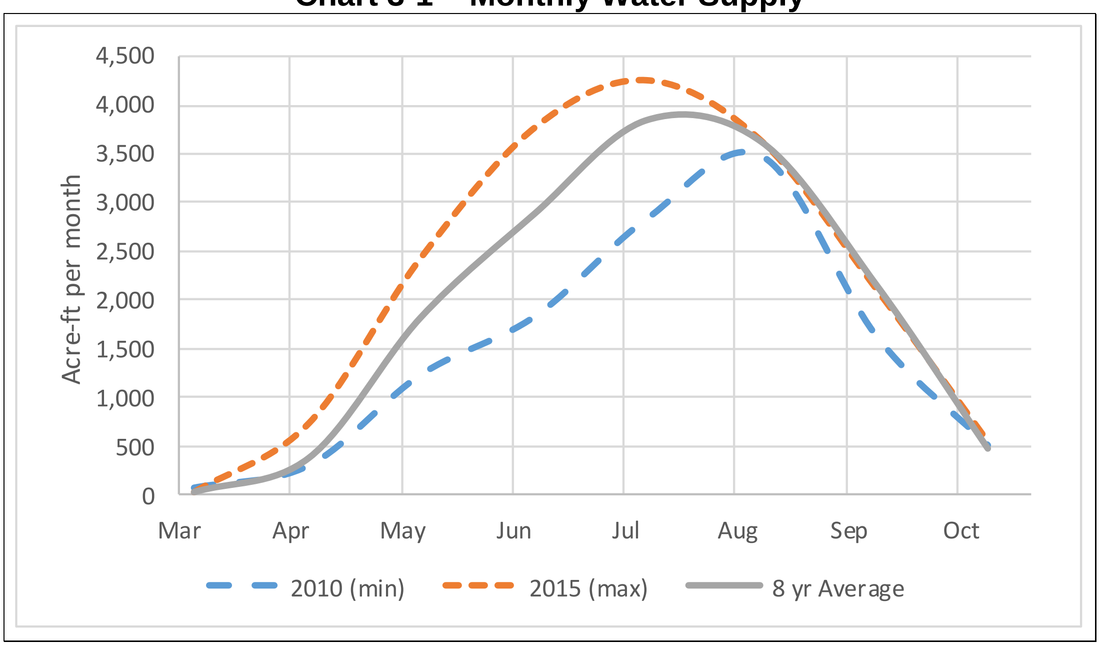
Table 3-2 – Monthly Water Supply in Acre-feet

Year	March	April	May	June	July	Aug	Sept	Oct	Total
2008	7	406	1,707	3,018	3,986	3,459	2,514	347	15,444
2009	6	383	1,752	3,474	3,960	3,791	2,137	581	16,084
2010	69	300	1,231	1,838	2,839	3,488	1,632	508	11,905
2011	13	240	691	2,098	3,580	3,912	2,865	355	13,754
2012	19	172	2,117	2,499	3,764	4,137	2,511	629	15,848
2013	13	420	2,110	3,092	4,102	3,313	1,317	220	14,587
2014	11	326	2,432	3,275	4,207	3,176	2,071	558	16,056
2015	34	741	2,426	3,772	4,253	3,630	2,113	552	17,521
Average	22	374	1,808	2,883	3,836	3,613	2,145	469	15,150

The hydrological flow system is very straightforward in the District's system. With no inflows or operational spills, only small conveyance losses due to pipeline breaks and small leaks constitute net outflow into drains. Because these small conveyance losses are less than 2 percent, they are not measurable within the accuracy of the flow meters in the system.

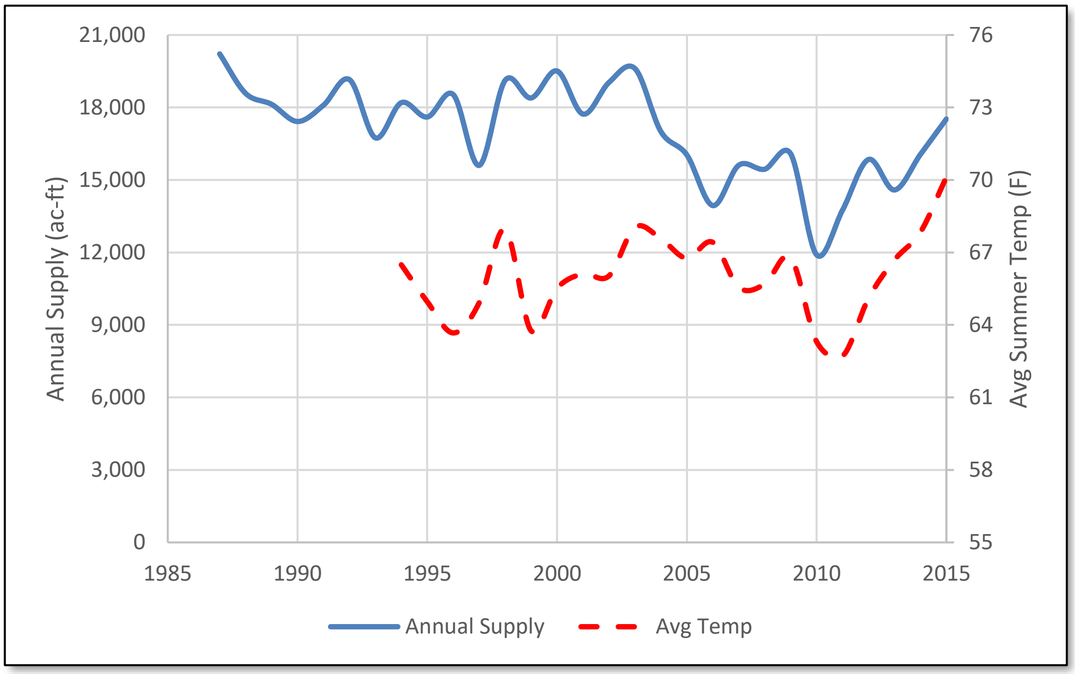
Annual supply has ranged between 12,000 and 20,000 afy, with recent water use ranging in the middle. Reductions are to be expected as farms have moved to more efficient on-farm irrigation systems. **Chart 3-1** shows a recent minimum year (2010), maximum year (2015), and the 8-year average.

Chart 3-1 – Monthly Water Supply



As shown on **Chart 3-2**, water use tracks closely with irrigation season temperatures. Average summer temperature dropped by 5 degrees Fahrenheit from 2003 to 2010, and has increased by 7 degrees Fahrenheit from 2010 through 2015. Weather data shown was obtained from USBR's Agrimet website for the Manson weather station (code MASW). Weather data from this station is not available prior to 1994.

Chart 3-2 – Annual Water Supply



The large drop in water supply from 2003 to 2006 is assumed to be an effect of the recession and a loss of orchards. Recovery and replanting has resulted in a gradual return of water supply.

4. Water Quality

The District operates a Group A domestic water system whose source is also Lake Chelan. Monitoring requirements for a Group A public water system include turbidity measurements, bacterial analysis, inorganic chemical and physical analysis, pesticide and radionuclide measurements, and volatile organic chemical analysis. Pertinent portions of these analyses are referenced in **Appendix H**.

The Department of Ecology's (Ecology) 2008 *Lake Chelan [dichloro-diphenyl-trichloroethane] DDT and [polychlorinated biphenyl] PCB [total maximum daily load] TMDL Water Quality-Implementation Plan* evaluated the water quality in Lake Chelan and Roses Lake. These chemicals become concentrated in fish and are consumed by humans. It concluded that DDT will continue to be deposited by soil erosion and groundwater from orchards that used the chemical in the past. PCB additions are primarily from rain. Water quality is expected to improve slowly as old chemical sources are used up, with an estimate of meeting quality standards by the year 2055. Wapato Lake and Joe Creek meet current standards. The report recommended continued monitoring and cleanup if any direct sources are located.

The Ecology's 2011 *Lake Chelan Wapato Basin Water Quality* report focused on phosphorus concentrations in the lake. The conclusion was that total phosphorus has been decreasing slightly since 1987, with the most recent measurements in 2007 of 2.6 micrograms per Liter (μg/L), which is below the TMDL criteria of 4.5 μg/L. This was confirmed by the low presence of chlorophyll-a and high water transparency. Agriculture was estimated to be a source of 4 to 12 percent of phosphorus.

Total nitrogen concentrations were measured at 80 μg/L, although there have been no discernable trends since 1987.

Chlorophyll-a was measured at 0.7 μg/L, although there have been no discernable trends since 1987. The reporting limit is 0.5 μg/L, but this does not indicate a water quality problem. Chlorophyll-a is used as a marker for evaluating phosphorus impacts.

Water transparency has very slightly improved from 1987 to 2007, with the latest value of 14 meters compared to 11 meters in 1987, though the upward trend lacks statistical confidence.

Dissolved oxygen has shown no trend changes since 1987, with current values near the water surface of 9 to 12 milligrams per Liter (mg/L). This is common for lakes that are low in plant nutrients.

pH levels have shown no trend changes since 1987, with values ranging from 7.3 to 8.2.

The 2011 water quality report recommended continued monitoring and development of consistent pollution control efforts.

Ecology's *Lake Chelan Water Quality Plan* produced in May 1991 drew conclusions and made recommendations regarding agricultural return flows from the District. These include the need for further drain monitoring, farm plans, and grower education.

Agricultural inputs are presently estimated to contribute 8±4 percent of the total phosphorus loading on the lake, 14±8 percent of the total nitrogen loading, and approximately 1 percent of the total arsenic loading. These nutrients comprise about 50 percent of the man-induced contributions and are, to an extent, controllable. Although the 1991 Ecology report suggests that the potential exists for much greater agricultural loadings to occur in the future, this has not been verified based upon the available arable lands and irrigation water supply.

In summary, the data suggest that application rates of irrigation water are relatively conservative given the existing crop requirements in the Lake Chelan basin. The volume of irrigation return flows is very small (less than 1 percent) relative to the other hydrologic inputs to the lake (Ecology, 1989). Furthermore, the existing market for recreational housing in the area suggests that the total acreage in orchard production is likely to decrease in the future. This decrease will result from the conversion of orchard lands to recreational and permanent housing given the projected population increase for the lake basin.

The areal export rates for phosphorus from agricultural areas within the basin are comparable or less than export rates from urban runoff (Ecology, 1989). While the areal export rates of nitrogen from those agricultural areas adjacent to Lake Chelan are higher than for any other land use type, the total lake input on an annual basis is 14±6 percent. Because phosphorus appears to be the more limited nutrient in the Lake Chelan ecosystem, it is unclear whether a reduction in nitrogen inputs, such as could be achieved from reduced fertilizer application, would result in any significant difference in the lake water quality.

In November 2015, the Food and Drug Administration implemented the Food Safety and Modernization Act (FMSA), which applies to water that is intended to, or likely to, contact the harvestable portion of the produce or food contact surfaces. The original rule was effective on January 2016, with compliance in January 2018 for water contact, and January 2017 for sprouts. An extension was granted on August 23, 2016. In summary:

- No detectable generic *E. coli* are allowed for water that can come in direct contact with produce near or during harvest, including sprout irrigation at any time;
- Geometric mean of no more than 126 colony forming units (CFU) of generic *E. coli* per 100 milliLiters (mL) of water; and
- Statistical threshold (90 percent of samples below value) of no more than 410 CFU of generic *E. coli* per 100 mL of water.

If the thresholds are exceeded, action must be taken within 1 year. Other options may be available, such as delaying harvest or washing.

- For untreated surface water, an initial survey (microbial water quality profile (MWQP)) of 20 samples minimum on each surface water source collected as close to harvest as practical over 2 to 4 years.
- Annual surveys of five samples on each surface water source per year are taken to update the profile using the data as a rolling dataset, where the oldest data will be replaced with the newest data in calculation the MWQP each year.

The District began testing in 2013. To date, results have been less than 10 CFU per 100 mL.

Chapter 4

FACILITIES AND OPERATIONS

1. Present Facilities

The Lake Chelan Reclamation District (District) operates 1 intake, 8 relift pumping plants, 4 booster pumping plants, 13 regulating reservoirs, 2 earthen-fill dams, 73 miles of distribution pipeline, 9.6 miles of drain lines, and approximately 670 farm turnouts. Approximately 256 acres are served through the District's separate Group A domestic water system. Each multi-pump station is automatically controlled to divert water at various instantaneous rates based on afterbay elevations in their respective regulating tanks.

The 13 afterbay reservoir tanks perform a variety of functions, including demand regulation, surge control, and flow control, as well as operating as the forebay for one of the eight relift pumping plants. Level transmitters or pressure switches turn various pumping operations on or off to meet demand or prevent emergency high or low level reservoir operations. Reservoirs have backup high level alarm floats.

The 8 relift pumping plants deliver water to the various pressure zones within the delivery system. The stations again pump to a reservoir tank that regulates pumped supply to meet outlet demand.

Four booster pumps on the system (A-a, C-a, F-a, and H-a) serve small acreages that are above the larger pressure zones. These booster pumps are turned on manually but will automatically shut off when pressures increase or supply is curtailed. Control is provided from local pressure switches. These stations are not currently connected to the telemetry system and are served power from Chelan County Public Utility District No. 1 (PUD).

The District owns and operates two earthen-fill dams. Antilon Lake Dam was the major regulating reservoir for the system prior to 1970. It is now operated only for flood control, recreation, and fish and wildlife purposes. Wapato Lake Dam is a joint use facility operated for irrigation, fish and wildlife, flood control, and recreation. Prior to 1970 it served as a re-regulating reservoir for the irrigation system. Today, a small amount of water is diverted from the lake for irrigation of adjacent lands. The Washington Department of Fish and Wildlife stocks rainbow trout annually in this popular fishing lake. In the last 7 years, catchable trout stocking has varied widely from zero to 16,000 per year. Largemouth bass and yellow perch have also been found in good numbers. **Table 4-1** shows recent fish stocking rates.

Table 4-1 – Stocked Fish Counts

Year	Roses Lake	Wapato Lake	Lake Chelan
2016	18,348	12,921	Not yet posted
2015	22,369	10,860	49,283
2014	16,856	16,515	39,574
2013	20,405	1,525	72,331
2012	12,921	400	39,737
2011	13,390	528	37,686
2010	18,273	0	59,435

The District's irrigation water is distributed through two separate systems. The irrigation distribution system has 73 miles of pipeline ranging from 6 inches to 48 inches in diameter. The domestic water system has 55 miles of pipeline ranging from 4 inches to 16 inches in diameter, through which a portion of the irrigation water rights are delivered.

The District delivers all water through metered turnouts. These turnouts have leak indicators that display when flow is going through the meters; however, the meters do not display instantaneous flow rate values. Totalizers record the volume of water used at each location. The District works to ensure that all meters remain in good working order and promptly repairs meters as necessary.

An overview of the irrigation system is shown on **Figure 4-1**. A hydraulic profile is shown on **Figure 4-2**.

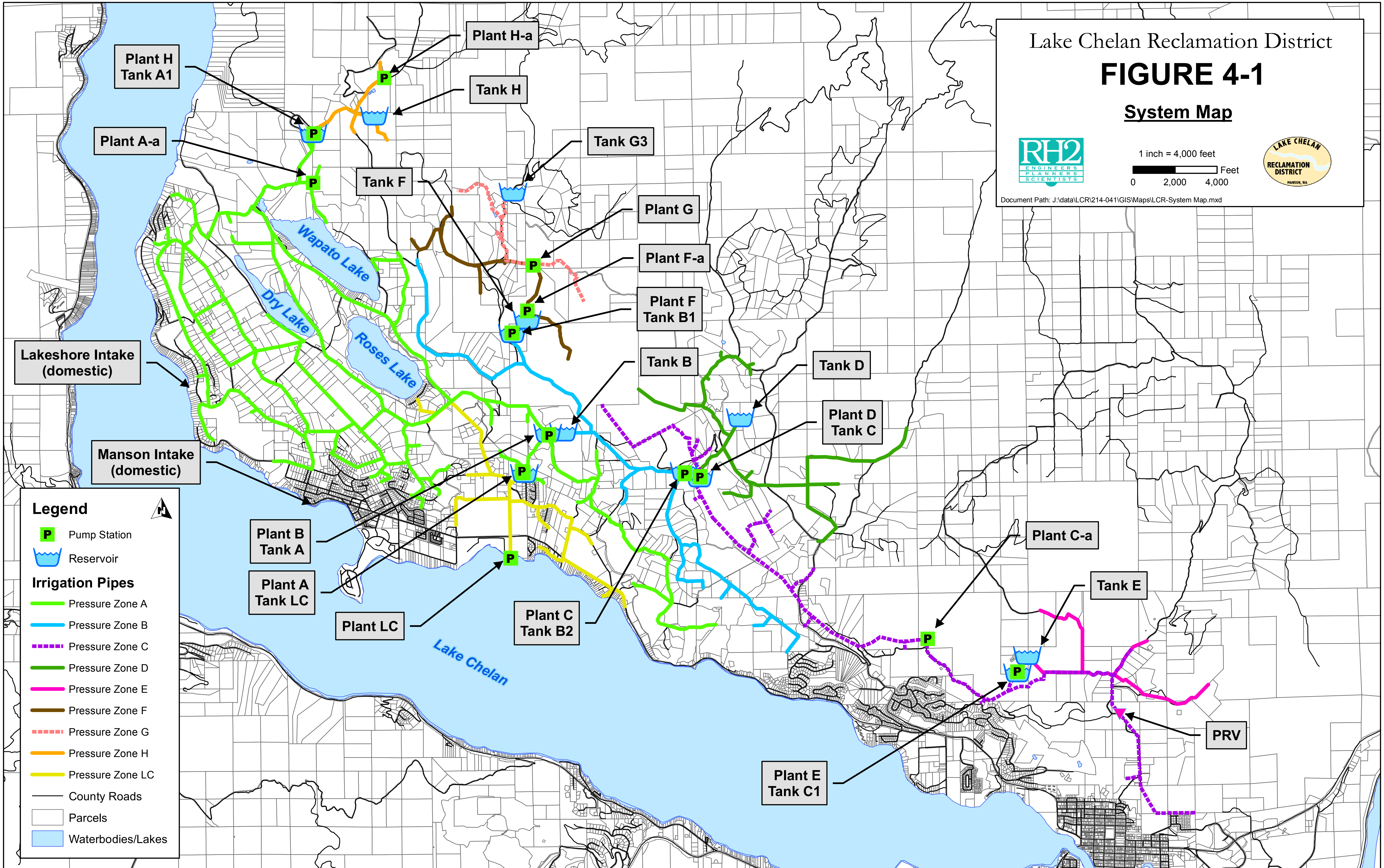
2. Operations

The irrigation facilities are operated so as to provide limited rate arranged service throughout the system when possible. During unusually warm weather, demand exceeds supply in some areas due to physical system capacity constraints. Peak daily use is typically between 6:00 am and 6:00 pm. Peak weekly use typically occurs in the middle of the week.

If high temperatures and evapotranspiration rates in late July and early August send the demand for water in some areas past available supplies, operations are modified to respond to this condition in several ways. The regulating tanks that do not operate as forebays for other pumping plants have their low water alarms disabled. This allows the relift systems to operate at slightly higher flows for short durations, with the only consequence being slightly lower pressures. All deliveries are also patrolled and regulated to a predetermined rate per acre. Some capacity bottlenecks in the system require that a lower rate rationing level be used on the upper systems. In past seasons, some farms in shallow soils have exhibited drought-stress symptoms due to an inability to meet peak evapotranspiration needs. More recent harvests have shown good quality fruit, indicating that operational changes by both the District and farms have addressed much of the prior water delivery issues. The domestic water facilities delivering irrigation water can provide on-demand service throughout the peak season.

The District allocates water use as follows:

- 36 inches per year on average (additional use incurs an excess charge);
- 8 gpm per acre maximum customer use.


Lake Chelan Reclamation District
FIGURE 4-1
System Map
RH2 ENGINEERS PLANNERS SCIENTISTS
1 inch = 4,000 feet
Feet
0 2,000 4,000
LAKE CHELAN RECLAMATION DISTRICT
Document Path: J:\data\LCR\214-041\GIS\Maps\LCR-System Map.mxd
Plant H-a
Plant H
Tank A1
Tank H
Tank G3
Plant A-a
Tank F
Plant G
Plant F-a
Plant F
Tank B1
Tank B
Tank D
Plant D
Tank C
Lakeshore Intake (domestic)
Manson Intake (domestic)
Wapato Lake
Dry Lake
Roses Lake
Plant B
Tank A
Plant A
Tank LC
Plant LC
Plant C
Tank B2
Plant C-a
Tank E
PRV
Plant E
Tank C1
Lake Chelan
Legend
Pump Station
Reservoir
Irrigation Pipes
Pressure Zone A
Pressure Zone B
Pressure Zone C
Pressure Zone D
Pressure Zone E
Pressure Zone F
Pressure Zone G
Pressure Zone H
Pressure Zone LC
County Roads
Parcels
Waterbodies/Lakes

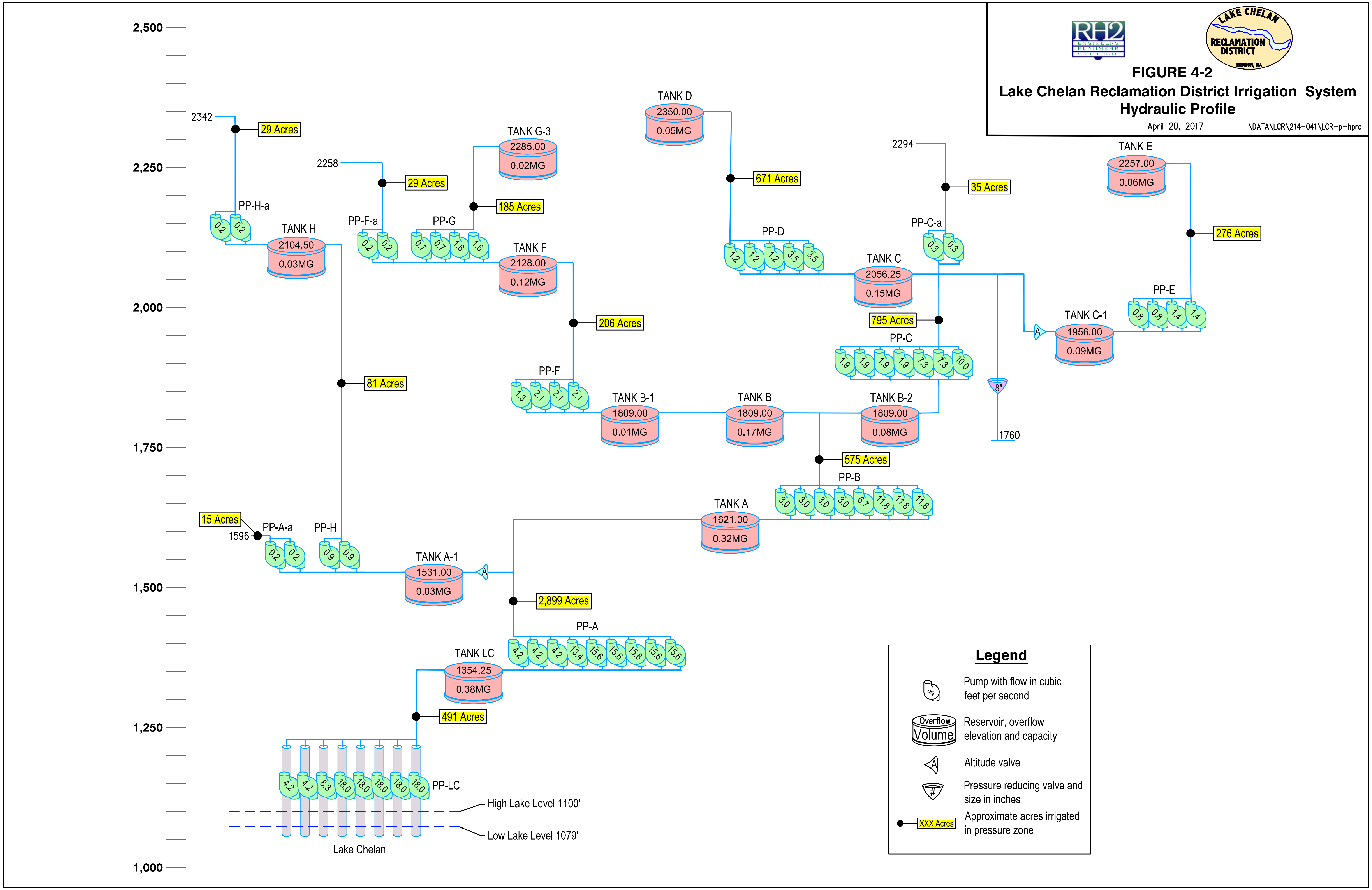


FIGURE 4-2
Lake Chelan Reclamation District Irrigation System Hydraulic Profile

District personnel regularly read customer water meters to check that individuals are not over-using their allocation. The District may shut off customers who over-use water until the issue is resolved.

3. Facility Performance

Pumping Plants

The Lake Chelan (LC) Pumping Plant Intake is the primary diversion for the irrigation system. Located at Mill Bay, the intake utilizes vertical shaft turbine-type pumping units in a formed concrete forebay that is protected by dual traveling belt water screens. The traveling water screens were installed to remove moss, trash, and debris passing through the trash racks and protect fish from being pulled into the pumps.

The Manson Pumping Plant is one of two diversions that pump water for both domestic and irrigation purposes. Located on Manson Boulevard approximately 1/4-mile uplake from downtown Manson, the intake utilizes three submersible-type turbine pumps. The pumps have multi-stage bowl assemblies and are mounted horizontally so as to draw water approximately 150 feet from the shore.

The Lakeshore Pumping Plant is the other diversion that pumps water for both domestic and irrigation purposes. Located off of Lakeshore Drive approximately 2 miles uplake from the Manson Pumping Plant, the intake utilizes two vertical shaft turbine-type pumping units in a formed concrete forebay. A fish screening facility protects the submerged intake pipes that supply the forebay.

The LC Pumping Plant and all other pumping plants were designed with the working stress method, using allowable stresses of 1,688 pounds per square inch (psi) for concrete with a 28-day compressive strength of 3,750 psi, and allowable stresses of 24,000 psi for all reinforcing steel with a yield strength of 60,000 psi. Load combinations of dead, live, snow, wind, hydraulic, thrust, earthquake, and temperature loads were accounted for under both the construction and operating conditions. None of the plants have shown any problems of structural vibration or cracking and all of the plants appear to be withstanding actual load conditions.

Pumping Plants A, B, C, and G contain pumping units of the horizontal single stage, double suction centrifugal type. The pumps are directly coupled to horizontal synchronous motors or horizontal induction motors. Each unit is designed to operate satisfactorily throughout the total head range listed in **Table 4-2 A through D**. Each unit also will operate safely in the reverse direction of rotation when water returns through the casing if the discharge valves fail to close. Each unit is designated to start against a closed discharge valve for water hammer control.

Pumping Plants D, E, F, H, C-a, and H-a contain pumps of the horizontal two stage centrifugal double suction or single suction type. The pumps are directly connected through a flexible coupling to a horizontal induction motor. Each pumping unit is designed to operate satisfactorily without detrimental surges, vibration, or dynamic imbalance throughout the entire range of total heads. Each unit, except the units at Pumping Plant C-a and H-a, is designated to start normally against a closed discharge valve for water hammer control.

Pumping Plants A-a and F-a contain pumps of the single stage horizontal centrifugal type with the suction nozzle located at the end. The nozzle is attached separately to the pump casing. Each pump is either rigidly connected or assembled through a shaft coupling to an induction motor. Each pumping unit is designed to operate safely in the reverse direction of rotation due to water returning through the pump at times when the power supply is interrupted and the check valve or discharge valve is not closed.

Pumping Plants LC, A, B, C, D, E, F, G, and H are controlled by the downstream regulating tanks. General operations are for pumps to cycle on as the reservoir level drops. The smaller pumps start first, with larger pumps coming on as tank levels continue to drop. Pumps are cycled off in the same sequence, with the smaller pumps dropping out first as the reservoir level recovers.

Tables 4-2.1 through **4-2.11** tabulate the pump station data.

Table 4-2.1 – Lake Chelan (LC) Supply Station

Pump No.	Rated Capacity		Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency		Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
	(cfs)	(gpm)					Initial	2010			
LC-1	4.20	1,880	267	240-295	1200	200	81%	74%	91%	2300	172
LC-2	4.20	1,880	267	240-295	1200	200	81%	74%	91%	2300	172
LC-3	8.30	3,730	267	240-295	1200	350	86%	75%	92%	2300	335
LC-4	18.00	8,080	267	240-295	1200	700	83%	80%	95%	2300	681
LC-5	18.00	8,080	267	240-295	1200	700	82%	80%	95%	2300	681
LC-6	18.00	8,000	275	240-320	1770	700	(1)	87%	95%	2300	645
LC-7	18.00	8,080	267	240-295	1200	700	81%	80%	95%	2300	681
LC-8	18.00	8,080	267	240-295	1200	700	82%	80%	95%	2300	681
Total	106.70										

Table 4-2.2 – Relift Pumping Plant A

Pump No.	Rated Capacity		Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency		Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
	(cfs)	(gpm)					Initial	2010			
A-1	4.20	1,880	277	256-288	1770	200	81%	54%	94%	2300	**244**
A-2	4.20	1,880	277	256-288	1770	200	78%	57%	94%	2300	**231**
A-3	4.20	1,880	277	256-288	1770	200	77%	53%	94%	2300	**249**
A-4	13.37	6,000	277	256-288	1785	500	(1)	65%	95%	2300	**646**
A-5	15.60	7,000	277	256-288	1800	600	85%	56%	95%	2300	**875**
A-6	15.60	7,000	277	256-288	1800	600	83%	64%	95%	2300	**765**
A-7	15.60	7,000	277	256-288	1800	600	85%	67%	95%	2300	**731**
A-8	15.60	7,000	277	256-288	1800	600	83%	71%	95%	2300	**690**
A-9	15.60	7,000	277	256-288	1800	600	84%	(2)	95%	2300	583
Total	103.97										

Table 4-2.3 – Relift Pumping Plant B

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
B-1	3.00	1,350	193	178-204	1775	100	82%	(2)	93%	2300	80
B-2	3.00	1,350	193	178-204	1775	100	81%	61%	93%	2300	**108**
B-3	3.00	1,350	193	178-204	1775	100	81%	59%	93%	2300	**111**
B-4	3.00	1,350	193	178-204	1775	100	81%	82%	93%	2300	80
B-5	6.68	3,000	193	178-204	1770	200	88%	66%	94%	2300	**221**
B-6	11.80	5,300	193	178-204	1770	350	89%	65%	95%	2300	**397**
B-7	11.80	5,300	193	178-204	1770	350	89%	75%	95%	2300	344
B-8	11.80	5,300	193	178-204	1770	350	88%	73%	95%	2300	**354**
Total	54.08										

Table 4-2.4 – Relift Pumping Plant C

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
C-1	1.90	850	270	230-290	1775	100	76%	54%	93%	2300	**108**
C-2	1.90	850	270	230-290	1775	100	78%	59%	93%	2300	99
C-3	1.90	850	270	230-290	1775	100	78%	58%	93%	2300	100
C-4	1.90	850	270	230-290	1775	100	77%	50%	92%	2300	**116**
C-5	10.03	4,500	270	230-290	1778	400	84%	(2)	(4)	2300	365
C-6	7.35	3,300	270	230-290	1770	300	79%	(3)	93%	2300	285
C-7	7.35	3,300	270	230-290	1770	300	81%	(3)	93%	2300	278
Total	32.33										

Table 4-2.5 – Relift Pumping Plant D

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
D-1	1.22	550	314	280-327	1775	125	60%	51%	93%	480	85
D-2	1.22	550	314	280-327	1775	125	57%	49%	93%	480	89
D-3	1.22	550	314	280-327	1775	125	56%	40%	93%	480	109
D-4	3.50	1,570	314	280-327	1775	200	80%	63%	95%	480	198
D-5	3.50	1,570	314	280-327	1775	200	82%	(2)	95%	480	152
Total	10.66										

Table 4-2.6 – Relift Pumping Plant E

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
E-1	0.84	380	304	277-316	1780	75	71%	(3)	94%	480	41
E-2	0.84	380	304	277-316	1780	75	69%	34%	94%	480	**85**
E-3	1.42	640	304	277-316	1775	125	59%	53%	94%	480	92
E-4	1.42	640	304	277-316	1785	150	58%	54%	(1)	480	91
Total	4.52										

Table 4-2.7 – Relift Pumping Plant F

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
F-1	1.29	580	347	308-356	1775	150	(4)	55%	96%	480	92
F-2	2.10	940	347	308-356	1775	150	(4)	60%	97%	480	138
F-3	2.10	940	347	308-356	1775	150	(4)	38%	(3)	480	**217**
F-4	2.10	940	347	308-356	1775	150	(4)	46%	(3)	480	**180**
Total	7.59										

Table 4-2.8 – Relift Pumping Plant G

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
G-1	0.72	320	184	147-192	1775	30	(4)	(2)	(4)	480	
G-2	0.72	320	184	147-192	1775	30	(4)	64%	(3)	480	23
G-3	1.56	700	184	147-192	3560	50	(4)	(2)	(4)	480	
G-4	1.56	700	184	147-192	3560	50	(4)	70%	(3)	480	46
Total	4.56										

Table 4-2.9 – Relift Pumping Plant H

Pump No.	Rated Capacity (cfs)	Rated Capacity (gpm)	Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency Initial	Pump Efficiency 2010	Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
H-1	0.95	430	583	550-590	3560	125	68%	62%	92%	480	101
H-2	0.95	430	583	550-590	3560	125	69%	50%	92%	480	**126**
Total	1.90										

Table 4-2.10 – Booster Stations

Pump No.	Rated Capacity		Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency		Motor Efficiency	Motor Voltage (V)
	(cfs)	(gpm)					Initial	2010		
A-a1	0.19	85	65	78-40	1800	5	(4)	(2)	(4)	480
A-a2	0.19	85	65	78-40	1800	5	(4)	(2)	(4)	480
A-a Total = 0.38										
C-a1	0.30	135	238	165-250	3540	25	(4)	(2)	90%	480
C-a2	0.30	135	238	165-250	3540	25	(4)	(2)	90%	480
C-a Total = 0.60										
F-a1	0.23	103	132	118-140	1765	10	(4)	(2)	(4)	480
F-a2	0.23	103	132	118-140	1765	10	(4)	(2)	(4)	480
F-a Total = 0.46										
H-a1	0.22	100	238	210-250	3540	25	(4)	(2)	90%	480
H-a2	0.22	100	238	210-250	3540	25	(4)	(2)	90%	480
H-a Total = 0.44										

Table 4-2.11 – Domestic Water System Supply Stations

Pump No.	Rated Capacity		Rated Head (ft)	Head Range (ft)	Rated Speed (rpm)	Motor Size (hp)	Pump Efficiency		Motor Efficiency	Motor Voltage (V)	Hydraulic Power (hp)
	(cfs)	(gpm)					Initial	2010			
Manson Intake											
1	1.82	820	445	350-500	1760	125	81%	(2)	87%	480	113
2	4.45	2,000	440	350-520	1760	300	81%	(2)	90%	480	274
3	2.67	1,200	420	350-450	1770	175	82%	(2)	(4)	480	155
Total	8.94										
Lakeshore Intake											
1	1.45	650	476	440-510	1760	100	82%	(2)	(4)	480	95
2	2.62	1,180	447	410-480	1770	200	83%	(2)	(4)	480	160
Total	4.07										

(1) Original pump or motor has been replaced, or a new pump was added since original project.
(2) Pump was not tested for 2010 report.
(3) 2010 pump test results appear unrealistic and are not shown here.
(4) No original information found.

No original pump curves have been found for pump stations F, G, Aa, Ca, Fa or Ha. Pump rated capacity and rated head shown in the above tables are copied from tabulations in prior reports.

The tables above include records of measured efficiency at the time of installation compared to measurements performed for a 2010 report (discussed later in Chapter 6). The 2010 report indicated most pumps are operating well below original design efficiency.

The Hydraulic Power column is a calculation of power draw if the pump is operating at full rated capacity and at the lesser of either the Initial or 2010 Pump Efficiency value. In many cases, this value is shown higher than the motor rating (Plant A, for example). This does not necessarily mean that the motor is being run over its rating, as the true pump capacity and efficiency are not exactly known due to a lack of accurate flow, pressure and electrical test data. But it does provide an indication that the pump may be coming due for an impeller replacement or other service.

Regulating Tanks

Steel regulating tanks are located at the end of the primary and relift pumping plant discharge lines. The height, diameter, and capacity of each tank is shown in **Table 4-3**. Each tank has a steel roof and is equipped with a roof hatch, two float wells, an outside ladder with a safety cage, inlet and outlet pipe connections, and an overflow. A 24-inch-diameter manhole is provided in the wall of each tank near the base to facilitate cleaning. On **Table 4-3**, the surface area columns are included to assist with future painting cost estimating.

Table 4-3 – Tank Physical Data

Reservoir	**Diameter** (feet)	**Tank Height** (feet)	**Depth to Overflow** (feet)	**Capacity** (gallons)	**Interior Surface Area** (sq. feet)	**Exterior Surface Area** (sq. feet)	**Overflow** (feet elev)
LC	50	28.50	25.75	378,189	8,404	6,440	1,354.25
A	47	27.00	25.00	324,434	7,457	5,722	1,621.00
A-1	15	26.00	24.50	32,385	1,579	1,402	1,531.00
B	40	20.00	18.50	173,893	5,027	3,770	1,809.00
B-1	8	47.50	45.00	16,919	1,294	1,244	1,809.00
B-2	18	47.75	44.80	85,274	3,209	2,955	1,809.00
C	33	26.25	23.75	151,944	4,432	3,577	2,056.25
C-1	25	26.50	25.00	91,793	3,063	2,572	1,956.00
D	26	16.50	14.00	55,599	2,410	1,879	2,350.00
E	22	24.00	21.50	61,133	2,419	2,039	2,257.00
F	26	32.00	30.00	119,140	3,676	3,145	2,128.00
G-3	17	16.00	14.00	23,769	1,308	1,081	2,285.00
H	19	16.00	14.50	30,752	1,522	1,239	2,104.50
Manson (raw)	66	40.00	39.50	1,010,825	15,136	11,715	1,504.00
Manson (finish)	55	72.00	70.25	1,248,426	17,192	14,817	1,534.00
Lakeshore	66	40.00	39.50	1,010,825	15,136	11,715	1,525.00

The irrigation system tanks are small compared to the pumping capacity. For example, Plant LC can supply over 45,000 gpm into the 0.38 million gallon (MG) LC tank. This could fill the entire tank in under 10 minutes. The tanks are used for short-term stabilization while pumps are cycled to keep up with demands. While this configuration resulted in the lowest original installation costs, it can be inefficient for operations when frequent pump cycling is required.

Tanks B, B-1, and B-2 are at the same overflow elevation, though only Tank B is used for pump control.

Tanks A-1, and C-1 are 90 feet and 100 feet lower than their main supply tanks A and C, respectively. The level in Tanks A-1, and C-1 are maintained with altitude valves that include speed controls. The tanks are relatively small and operated at roughly half full to allow response time should the altitude valves fail.

Dams

Antilon Lake Dam, built in 1913, is comprised of three separate embankments: a main embankment and two saddle dams. The main dam is a hydraulic fill embankment 62 feet high and 300 feet long with a crest width of 20 feet. The upstream slope is 3H:1V, and the downstream slope is 2H:1V. The dam has a downstream hazard classification of 1B High Hazard with a risk to between 31 and 300 people.

Antilon Lake originally had two saddle dams. One of them was breached to address Ecology dam safety issues. Antilon saddle dam number one is an earthen-fill embankment 25 feet high and 900 feet long with a crest width of 15 feet. The saddle dam has a 3H:1V upstream slope, and a 2H:1V downstream slope. The dam was constructed by conventional means to an elevation 1 foot lower than the main dam. Saddle dam number two is a homogenous earthen-fill embankment with a height of 15 feet, a crest length of 150 feet, and a crest width of 15 feet. A May 1991 draft report issued by the Dam Safety office of the Washington State Department of Ecology (Ecology) indicates that most elements of the Antilon and saddle dam facilities meet current engineering standards for dam design, construction, and operation.

Wapato Lake Dam, built in 1912, is a zoned earthen-fill embankment with a sloping upstream puddled impervious core zone, and coarse-grained upstream and downstream shells. The embankment is 20 feet high and 540 feet long with a crest width of approximately 30 feet. The upstream slope is 3H:1V, and the downstream slope is 1.2H:1V. A May 1991 draft report by Ecology's Dam Safety office indicated that under extreme conditions (i.e., floods or earthquakes), the Wapato Lake Dam does not meet current engineering standards. Modifications to the spillway, embankment, pressure pipeline, and outlet works were completed by September 1995 to improve the safety of the dam. The dam has a downstream hazard classification of 1C High Hazard with a risk to between 7and 30 people.

Ecology performed an inspection in 2013 on the Wapato Lake Dam and found the need for maintenance of the conduits and spillways, as well as general vegetation control. The District provided the required maintenance soon after. The Ecology report is included in **Appendix I**.

Pipelines

Most of the 73 miles of pipeline in the District are performing satisfactorily for their intended uses and life expectancy. One material type, reinforced plastic mortar (RPM), has shown a propensity to fail catastrophically and without warning. The District replaced approximately 3 miles of RPM pipe ranging in diameter of 27 inches to 45 inches between 1992 and 1996.

Approximately 90 percent of the District's pipe is asbestos cement (AC), also known as "transite". Other materials, including concrete cylinder pipe, steel, ductile iron, and polyvinylchloride (PVC) are used throughout the system. Approximately 96 percent of the pipe in the irrigation system is over 40 years old.

Pipes are leak tested each spring, as timing allows. Recent testing has indicated a very low leak rate of less than 1 percent.

There is only one mainline pressure reducing valve in the system: an 8-inch-diameter valve located on the east end of the system on the C-9 lateral.

Table 4-4 shows the large transmission mains that run between the pump stations and reservoirs.

Table 4-4 – Major Station Transmission Mains

System	Diameter (inch)	Length (ft)	Area (sq ft)	Flow (cfs)	Velocity (fps)
LC	48	4,180	12.57	106.7	8.49
A	45	2,245	11.04	103.97	9.42
B	33	647	5.94	54.08	9.1
C	30/27	208/488	4.91/3.98	32.33	6.58/8.13
D	18/15	1,886/1,620	1.77/1.23	10.66	6.02/8.69
E	12	853	0.79	4.52	5.72
F	15	931	1.23	7.59	6.17
G	10	2,000	0.55	4.55	8.27
H	10	3,356	0.55	1.9	3.45
Manson	16	2,000	1.4	6.92	4.99
Lakeshore	16	9,000	1.4	1.9	1.36

fps = feet per second

Customer Turnouts

The 1971 U.S. Bureau of Reclamation contract called for one metered turnout per each 20-acre tract, or a combination of tracts totaling 20 acres, with some exceptions for smaller tracts. There are approximately 687 customer turnouts. All turnouts include meters and many have pressure reducing valves. Supply to farms is generally not limited by flow control devices, except for orifice plates installed on some farms where water over-use is habitual. Customer meters are shown in **Table 4-5**.

Table 4-5 – Customer Meters by System

System	Number of Meters by Diameter							Total
	3/4"	1"	1.5"	2"	3"	4"	6"	
LC	1	39	1	27	13	7	0	88
A	5	76	3	170	114	8	1	377
B	0	1	0	20	28	3	0	52
C	0	7	0	21	26	9	1	64
D	0	3	0	8	18	14	1	44
E	0	1	0	9	13	1	0	24
F	0	0	0	5	7	4	0	16
G	0	1	0	6	5	3	0	15
H	0	0	0	1	5	1	0	7
Total	**6**	**128**	**4**	**267**	**229**	**50**	**3**	**687**

Drains and Streams

The addition of irrigation systems to previously fallow lands created new surface and groundwater flows. To manage these flows, the U.S. Bureau of Reclamation constructed 25 drains, including 0.2 miles of open drain, 9.4 miles of closed pipe drain, and 2 drain pump stations. These drains convey subsurface waters from irrigated lands to either Lake Chelan or the Wapato, Roses, and Dry Lakes basin. Drainage problems on irrigated lands are reduced significantly by the operation of the drainage system, although in certain areas and during certain times of the year, subsurface groundwaters can be a problem.

The District regularly inspects and cleans the drain systems, but the long distance between many manholes, often exceeding 1,000 feet, makes it difficult or impractical to reach all facilities for maintenance.

Several other perennial and seasonal streams as delineated on the maps are recognized throughout the District.

Telemetry and SCADA

The irrigation system and sanitary sewer system are operated from the same remote telemetry system. The domestic water system is operated from a separate telemetry system.

The original hard-wire control system was replaced in 1997 with a modern remote telemetry system. That system has been upgraded periodically with new hardware and software, though the general architecture of the system has not changed. Currently, the system communicates via radio, with many stations bouncing the signal off a radio tower owned by Icicle Broadcasting on the south shore of Lake Chelan.

All pump stations and reservoirs are monitored and controlled through the telemetry system, except for Pump Stations A-a, C-a, F-a, and H-a, which have only local control.

Control communications within the individual boundaries of Stations LC, H, and F use radios rather than hard wire.

A wide range of data is monitored and recorded, including flow, pressure, pump status, tank level, and multiple alarms.

Chapter 5

WATER NEEDS AND ADEQUACY OF SUPPLY

1. Land Use Trends

Currently there are only 50 acres of commercial agriculture zoned lands within the Manson and Chelan urban growth areas (UGA)s. Based on the projected growth rates shown in **Chapter 2**, it could be estimated that 5 acres of agricultural land may be converted to residential use per year.

There is an estimated 100 acres of undeveloped or idle agricultural lands, or about 5 to 10 acres per year, that may be brought into fruit production during the next 10 to 20 years.

A small sampling of residential type lots in the Manson area show an average gross water application rate of 27 acre-inches per acre. This compares to an average gross water application rate of 35 acre-inches per acre on fruit-producing agricultural acres. This means that every acre of land converted from agricultural use to urban use will net an average savings of 8 acre-inches per acre.

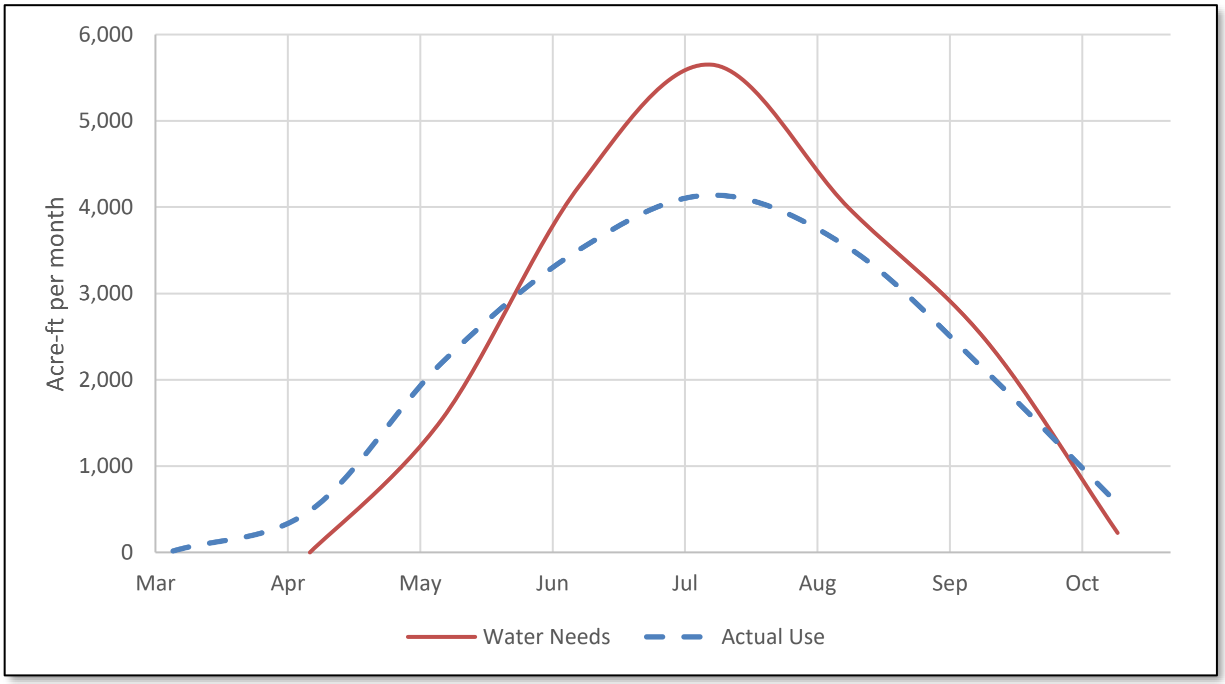
10 acres/year x 35 ac-in/acre	=	350 ac-in/yr
-5 acres/year x 8 ac-in/acre	=	-40 ac-in/yr
Net Additional Water Demand	=	310 acre-inches/yr
	=	26 ac-ft/yr

2. Crop Supply

Crops within the Lake Chelan Reclamation District (District) change gradually and infrequently. The current estimate is 90 percent apples, 7 percent cherries, 2 percent pears, and 1 percent grapes. The wine tourist industry has made significant gains in the last decade, but actual acreage of wine grapes is low compared to other crops.

Cropping patterns of the future should not be significantly different than the present. The Lake Chelan area is one of the premier apple growing regions in the world. The future will see newer varieties and some new irrigation systems, but these factors alone will not significantly improve water use efficiencies. **Chart 5-1** shows a comparison of actual water pumped (Actual Use) to the ideal crop requirements (Water Needs) as described in the Washington Irrigation Guide (WIG). If warming trends continue, the crop water requirements should be expected to increase.

Chart 5-1 – Water Needs vs. Water Use



Current estimates are that 75 percent of irrigation systems use micro heads (85 percent efficiency) and 25 percent using impact sprinklers (70 percent efficiency). This results in a total system application efficiency of approximately 81 percent. Farms vary in irrigation methods depending on soils, topography, type of sprinklers, and operator ingenuity. It is common for an orchardist to water heavy in one period to saturate the soils, then rely on the water holding capacity of the soil to supply the crops while the system is off. One week on, one week off is a common pattern.

The October 2014 report by RH2 Engineering, Inc. (RH2) in **Appendix K** provides a more detailed description of crop watering needs.

Over the last 12 years, water use has tracked closely with average growing season temperature. The annual water supply changes by approximately 1,500 acre-feet for each 1 average degree Fahrenheit change. Should current warming trends continue, farms are expected to request additional water.

3. Future Service Area

The District can serve 6,600 acres by water rights, and currently assesses 6,336 acres. This leaves another 264 acres which can be served, assuming the physical system capacity is available.

The District is working with the U.S. Bureau of Reclamation (USBR) to incorporate additional irrigable land into the District in locations where sufficient physical capacity is available.

The owners of 8 parcels totaling approximately 450 acres, 350 acres of which is currently farmed, in Section 28 near the D system have requested supply from the District. Currently, the D system is over capacity. Expanded service would require significant system improvements. The existing pipes may have capacity for perhaps another 100 acres. The pumps are currently over capacity. If this issue is to be pursued, a full analysis should be performed.

4. Capacity Evaluation

RH2 Engineering, Inc., (RH2) prepared a physical system capacity evaluation in 2014, which is included in **Appendix K**. The findings of that evaluation are summarized here.

- All systems can supply the 6.9 gallons per minute (gpm) per acre original design intent except the D system, which is 2 percent under capacity.
- The C-a, F-a, G, and H-a systems are at full capacity when estimates for leakage and pump wear are included.
- Expansion of service in systems A-a, C-a, D, F-a, and H-a will need pump, and possibly pipe, improvements.
- G system excess/surplus capacity is not known due to a lack of pump flow rate information.
- Peak day crop needs are estimated at 7.9 to 8.5 gpm per acre. Systems LC, A, B, C, and F can meet this demand directly, though not all at the same time.
- Systems A-a, C-a, D, E, F-a, G, and H-a cannot meet the orchard needs alone between mid-June and early August. The water holding capacity (WHC) of the soils must be efficiently used during this period. This requires initiative and planning by the farmers.
- Some systems can supply additional acres (or increased flows to existing acres) with the current pumps and pipes if farms use the soil WHC effectively. The following totals show the maximum additional acres that could be serviced. The values are not additive. Acres added in one system will reduce those available in other systems.
  - LC = 642 acres
  - A = 444 acres
  - A-a = 9 acres
  - B = 142 acres
  - C = 281 acres
  - E = 14 acres
  - F = 66 acres
  - G = unknown
  - H = 14 acres

5. Opportunities for Improvement – Needs

The District's major opportunity for improvement in water efficiency lies in maximizing the instantaneous water delivery to farms. Instantaneous demands often exceed supply for approximately 2 months per year. This deficiency causes the users to irrigate when the water is available rather than when the soil's water holding capacity is depleted to an acceptable level. The net effect can be increased surface runoff and/or deep percolation.

The District's operations are modified when demand exceeds supply. In the last 15 years, technology and water application procedures have greatly improved to the point where past drought symptoms have not been seen recently.

The District does not qualitatively judge who needs water at a given time. The on-farm systems and farming practices are, on a whole, very good. Irrigation scheduling and better crop needs assessments would improve water use efficiencies for most users. There is a need to collect better weather and soil moisture data and provide it in a usable form to the farmers.

The modernized telemetry and control system on the irrigation system provides significantly improved monitoring and control. Staff can now see where demand is highest on the system and ensure proper supply occurs on that portion of the system, and staff can increase patrols in those areas for customer over-use. As a better record is produced regarding these demand events, additional structural improvements may be necessary to respond automatically to increased demands.

There are several rehabilitation projects that improve system integrity but do not provide quantitative water savings. Rehabilitating pumps and motors improves electrical efficiency and helps minimize disruptions in service due to mechanical failures. Rehabilitating the regulation storage tanks will guarantee long-term reliability and better system control. Rehabilitating or replacing electrical transformers will improve reliability and safety.

Irrigation meters and pressure regulators are beginning to lose their reliability. The consequences of meters that fail is both reduced accountability and increased skepticism by water users that the devices provide reliable information. When pressure regulators fail, it can be catastrophic to the on-farm distribution systems and cause significant water wastage. Indirectly, the meter failures can lead to a more relaxed attitude towards water use and water management.

Chapter 6

OPPORTUNITIES FOR IMPROVEMENTS

1. System Age Assessment

The Lake Chelan Reclamation District's (District) existing irrigation system is well maintained. However, the vast majority of the system is over 40 years old. The District's pipes are mostly asbestos cement, which has a life expectancy of 100 years or more if left undisturbed. The pump station piping is mostly coated steel, which may also last 100 years if the coating is rigorously maintained. The expected life for pumps, control valves, and motor control centers (MCCs) is substantially less, typically 25 to 50 years. A long-term improvements and financing plan for replacement of pumps, valves, and MCCs must be developed. The cost for fully funding this depreciation of the Capital Improvement Plan is presented in **Chapter 7**.

2. Opportunities for Improvements – Non-structural

The most significant opportunity to improve water efficiency using non-structural alternatives is to better manage irrigation practices on-farm. Farmers will make sound management decisions if provided accurate and reliable information in a timely manner.

The District sends out letters with assessments that inform the customers of District policies, operational recommendations, and recent physical or legal issues that may be relevant.

Irrigation Scheduling

An Irrigation Water Management (IWM) program was developed around the year 2000 to help provide information and education needed to incorporate modern irrigation scheduling techniques. The IWM program provided both information and technical assistance to between 60 and 100 growers initially. A District technician was assigned to work with the individual famers on their water scheduling techniques. Using soils information, topography, tree spacing, on-farm system layout, and sprinkler specifications, the technician determined the farm system capabilities. Soil moisture data was then collected and monitored on a weekly basis using a non-nuclear soil moisture probe. Charts were printed and distributed to growers to correlate soil moisture, field capacity, allowable moisture depletion, and crop irrigation requirements.

The program considered enhancements, including demonstration projects using a variety of in-situ soil moisture monitoring devices, pressure, and flow recorders to evaluate instantaneous flows for various irrigation sets, together with other technical enhancements to provide more accurate and timely information.

The IWM program was used for about 10 years, then discontinued due to the small number of farms who showed interest and participated. No new program is currently proposed.

Weather Stations

Current evapotranspiration values are obtained from the Agri-Met weather station installed near the 'G' Pumping Plant. While this data is relevant to the acreage near that pumping plant, and to lands of similar elevation, sun, and wind exposure, it is not relevant to all lands. The micro climates of the District vary significantly. Evapotranspiration data could be enhanced significantly by adding air temperature, wind speed, and precipitation at other key irrigation pumping plants throughout the District. The data could be coupled into the existing remote telemetry units and adjustments could be made in the evapotranspiration calculation to reflect the various micro climates. The end result would be an enhanced water "check book" analysis of irrigation scheduling. With modern technology, much of this same information can now be provided privately on individual farms at a reasonable cost. Due to the low cost for private installations, no new program is currently proposed.

Land Classification

Another non-structural way to improve District water efficiency is to monitor compliance of plantings within irrigable areas. One methodology is to use publicly available satellite photography with District assessed lands overlaid from the Geographical Information System (GIS) dataset. Periodic review of plantings with current aerial photography is necessary. In some cases, orchards may be planted on non-irrigable lands while lands classified as irrigable remain idle. The District will benefit by getting lands reclassified to reflect actual use.

When new orchards arrive in the District, either by creating new farms or purchasing existing ones, the District educates the orchardists by reviewing soil and land use mapping, explaining the District policies, and assisting with planning irrigation system layout.

This effort is a management reliability program that may or may not result in quantitative water savings.

3. Opportunities for Improvements – Structural

Telemetry Control Enhancements

The telemetry system currently operates with radio communication. Radio signal reliability has been unsatisfactory at the remote E Station. Options to improve the communications include dedicated hardwire, Chelan County Public Utility District No. 1 (PUD) fiberoptic, and PUD wireless.

Booster stations A-a, C-a, F-a, and H-a could be added to the remote telemetry system. The current lack of monitoring and control results in higher than necessary power costs and possible abuse by customers interfering with the station operation.

Aging equipment will be replaced when replacement parts are no longer readily available. Currently, the RUGID RUG6 remote telemetry units (RTU) at the LC, G, and H Pumping Plants are planned for replacement. The other stations will likely require replacement within 6 years.

The District pays a lease fee to Icicle Broadcasting for relaying radio signals across Lake Chelan. Replacement of radio systems with hard wire would eliminate the lease at the cost of initial wire installation.

Pipeline Replacements

Approximately 96-percent of the 16,000 linear feet of small service lines between the mains and customer turnouts were built of steel in the 1970s. Sizes range from ¾-inch to 6-inch diameter. A long-term plan for replacement of these service lines should be developed. The Capital Improvement Plan (CIP) assumes that the District crew will perform the work to replace the service lines. The cost estimate in **Chapter 7** reflects only the cost for materials and road restoration.

There are also 1,100 linear feet of 2-inch steel air valve supply lines and 700 linear feet of 2-inch steel drain lines installed in the 1970s that should be budgeted for replacement.

Pump Station Improvements

Efficiency and Condition Studies

A study was performed by EMP2 Inc. in 2009/2010 to evaluate the existing pump efficiencies and provide recommendations for improvements. Conclusions were made with the assumption that much of the costs would be covered by the Bonneville Power Administration (BPA), as BPA would then be able to sell the power saved on the open market to finance the program. The BPA funding program was terminated shortly after the 2009 study and before any of the projects could be implemented. The recommendations of that report were as follows.

1. Plant LC: Install one variable frequency drive (VFD) to soft start all pumps, but speed control only one pump at a time.
2. Plant A: Install VFDs on pumps 8 and 9.
3. Plant B: Install a VFD on either pump 6, 7, or 8. Replace pump 7.
4. Plant C: Install a new pump with a VFD. Optionally, remove pump 4 and install in that space.
5. Plant D: Install a VFD on either pump 4 or 5. Replace pump 3.
6. Plant E: Replace pump 2 or 4 and install a VFD.
7. Plant F: Replace pump 1 or 3 and install a VFD.
8. Plant G: Replace pump 1 and install a VFD.
9. Plant H: Replace pump 2 and install a VFD.

The study concluded that only four of these projects were warranted, but it did not clearly specify which four projects. Assuming the basis of selection is the rate of payback, the projects in order of highest benefit are numbers 5 (Plant D), 7 (Plant F), 2 (Plant A), and 3 (Plant B).

Since the 2010 EMP2 Inc. report, the technology to evaluate pump condition and efficiency has improved. Some of the assumptions in the 2010 report were also found to be incorrect, such as pump rotational speed at Plant LC, and cost estimates that appear optimistic. The methodology used in that report for evaluating gains from VFDs was also not clearly explained. A new comprehensive evaluation of pump conditions using vibration, hydraulics, and power analyses may provide a different set of recommendations.

The Hydraulic Power column calculations in **Tables 4-2** in Chapter 4 indicate that some pumps may be running their motors over the power nameplate rating. It is recommended that power draw measurements be performed at these pumps to verify the actual load on the motors.

The combination of small regulating reservoirs and large number of pumps results in frequent starting and stopping of pumps. This action can reduce the life of motors and bearings, and increase the risk of water hammer. Inclusion of one or more VFDs in a station would improve these conditions.

Capacity Upgrades

Structural opportunities exist to improve the instantaneous water delivery to farms. Increased pumping capacities would translate into higher instantaneous water delivery. In turn, as the system more closely supplies what is being demanded, the system will have fewer interruptions of service and fruit quality should improve.

Additional pumping capacity at Pumping Plants D, E, and H would be needed if some non-planted acreage is brought into production. The exact flow requirements and flow improvement methodology will need to be confirmed at a later date. In some cases, a change in impeller size on an existing pump and motor may yield the desired result.

Plant D currently cannot keep up with demand during peak irrigation times. The 2010 EMP2 Inc. report indicated that pump D-3 was performing poorly and recommended replacement. The existing pump is rated at 548 gallons per minute (gpm), but was measured at 494 gpm and 40 percent efficiency. Per the 2014 RH2 Engineering, Inc., *Lake Chelan Reclamation District Irrigation Supply Capacity Evaluation* report (**Appendix K**), an increase of 193 gpm is required just to meet current ideal crop requirements. Replacing pump D-3 with a 750 gpm pump is possible; however, the piping hydraulics should first be reviewed.

Land owners in the Plant D system have asked about being included in the District. Assuming 350 acres were added, the additional capacity needed is approximately 2,400 gpm. This would require a major upgrade to Plant D, and possibly the transmission mains too. The design and cost of the project is outside the scope of this Comprehensive Water Conservation Plan (Plan) and should be addressed in a separate study, if the land owner(s) wishes to pursue service. The project is shown in the CIP, but no budget is assigned. It is possible that the District would require the properties benefitting from this improvement to pay for the project.

Another structural improvement aimed at improving pumping capacity and efficiency utilizes a rehabilitating agent from the Belzona Company called Belzona 1341 (Supermetalglide). Supermetalglide is a coating system applied to pump casings and impellers that reduces frictional drag without changing the flow characteristics of the equipment. Smoother surfaces lead to less turbulence and greater efficiency.

Maintenance and Assessment

Pumps and motors need rehabilitation on regular intervals. Motor re-windings, bearing replacements, and shaft realignments are all system integrity elements that ensure the pumps remain in good working order. Periodic condition assessments, including vibration analyses, can be performed to assist with major maintenance decisions.

Pump A-4 was replaced with a larger capacity pump in 1993, but the existing station piping (designed for a much smaller pump) was retained. At the 6,000 gpm rated capacity, velocity through the 10-inch intake and 8-inch discharge are 25 and 38 feet per second, respectively. These are far in excess of standard design practices, which would typically recommend velocity of half this or less. However, the District has not noted any performance deficiencies to date. At these velocities, a number of problems would normally be expected, such as pipe coating wear and pump or valve cavitation. The pump should be inspected for damage within the next 5 years.

Valve Replacements

The pump control valves at the major stations are mostly the pneumatic/hydraulic cone or ball-style valve. These are complex and high maintenance valve systems. The speed control systems can be inconsistent and the valves occasionally stick during operation. Valve overhaul service is available from limited service companies in the country. Maintenance requirements have been increasing as this equipment ages. Replacing the existing valves with globe-style hydraulic valves would allow for the District to perform much of its own service, assuming there is sufficient space available for installation.

Globe-style pump control valve costs range from $8,000 for 4-inch, to $24,000 for 12-inch, to $52,000 for 20-inch. Replacement of all 50 valves would cost approximately $900,000 for just the valves. The District crew could perform the installation, though electricians and telemetry technicians would be required for full implementation. Globe valve have significantly higher headloss than cone/ball valves, therefore installation of globe valves on all stations may increase power usage by 1.8MWh per year, or approximately $20,000 per year.

The pneumatic cone valves currently provide some water hammer protection by slowly closing during a power failure, rather than slamming shut. Replacement with globe valves may require additional water hammer protection measures be added at the pump stations, such as a surge anticipator valve that discharges back to the reservoir.

Because the globe valves would result in higher electrical costs and the loss of automated water hammer protection, the existing cone/ball valve systems will be retained. The District budget should include an allowance for the rebuild of one or more valves per year.

To remotely indicate problems with stuck or slow pump control valves, continuous position sensors could be added at each valve. This would have to be done with a corresponding RTU upgrade to provide enough analog inputs for monitoring.

The pneumatic valves are currently the only discharge valves on many pumps. To remove and service one of these valves requires a shutdown of the entire pump station. The addition of manual isolation valves on all pumps will improve up-time during maintenance. Some pumps have already been retrofitted. Installation of valves by the District crew is included in the CIP.

Automated Startup

Lightning strikes at pump stations are common and can result in a shutdown of the entire irrigation system depending on which station is hit. Restarting the system requires manual throttling of valves until the system has filled to prevent the pump motors from overloading and pumps from cavitating on a runaway condition. One possible remedy for this condition is to use a VFD to control the fill rate. Another option, if globe-style pump control valves are installed, is to include a backpressure sustaining feature on one or more of the valves.

Meter Improvements

Rehabilitating irrigation meters on a continuing program will maximize control of the District's water. Meter replacement should be scheduled on a 15-year rotation. Accurate water measurement is an important feature in overall water management.

There are approximately 40 large (3-inch, 4-inch, and 6-inch) original mechanical meters that need to be replaced due to wear and inaccuracy. The District has adopted electromagnetic meters as the preferred replacement standard to eliminate problems with debris and wear. Meters this large are expensive, and the District is pursuing a water efficiency grant to help with the cost of replacement.

Electromagnetic meters are readily available in most sizes, with a published accuracy range of plus or minus 1 percent from 0.5 to 30 feet per second (varies by manufacturer). Installation standards recommend 5 to 10 pipe diameters of straight pipe upstream and 2 to 5 diameters downstream, depending on the manufacturer and the type of flow disturbance. When this spacing is not available, strainers can be added or turbine style meters can be substituted.

Pressure Reducing Valve Improvements

Approximately two thirds of the customer turnouts include pressure reducing valves (PRVs). Replacing or rehabilitating pressure reducing valves will directly save water. As the existing PRVs lose their reliability, pipe failures in the on-farm systems occur more frequently. Resizing the PRVs, together with rebuilding and replacing valves where applicable, will eliminate water wastage from the on-farm breaks. PRV rebuilds and replacements should be included in a continuing budget rotation. Replacement of 25 valves per year would give an approximate 20-year life cycle.

The 8-inch mainline PRV on lateral C-9 near Union Valley Road flows a significant amount of water that could be used for power recovery if a micro turbine is installed. It may be possible to generate around 20 horsepower (hp), on average, during the irrigation season, though instantaneous power will vary. However, the closest District pump station is 1 mile away. Assuming the power could be sold to Chelan County PUD No. 1, the returns may be approximately $2,000 per year. The cost to build the generation equipment compared to the dollar return does not appear feasible at this time, but may be re-evaluated as power costs increase.

Electrical Improvements

The pump station MCCs are 40 years old and require frequent service. Replacement parts are difficult to acquire, and obsolete in many cases. Typical life expectancy of MCCs is 25 to 35 years. Replacement of all MCCs is recommended to occur based on the critical rating of each facility. Generally, this means the facilities should be replaced starting at the lowest and largest stations, Plants LC and A. The District may need at least 2 years to plan and budget for these projects.

Installation of one or more VFDs at the major stations would improve efficiency by allowing use of the most efficient pumps for the longest periods of time and reduce the number of pump starts and stops. The 2010 EMP2 Inc. report provided some recommendations; however, some of the assumptions and measurements in that report are insufficient for proper equipment selection. An updated analysis for each system should be provided if VFDs will be pursued. The cost for the analyses and an assumed replacement program is provided in the CIP.

National Fire Protection Association (NFPA) 70E and Occupational Safety and Health Administration (OSHA) 1910 require an arc-flash analysis for most types of new electrical equipment that has panels likely to be serviced by a worker. An analysis on large existing gear is recommended for worker safety. The CIP budgets this work for 2017 through 2020, assuming two pumping plants will be evaluated per year.

Reservoir Improvements

Rehabilitation projects that result in system integrity improvements without quantitative water savings are also important structural elements. The regulating reservoirs in the system will continue to need rehabilitation during their life. Regularly upgrading control floats, wiring, cathodic protection, and painting will lead to long-term system reliability and should be included in a rotating budget plan. The first reservoir that is expected to need repainting is reservoir LC, which is shown in the CIP for the year 2026.

The 2010 EMP2 Inc. report offered a long-range option of installing larger reservoirs to take advantage of off-peak pumping. While the efficiency benefits described in that report appear accurate, the infrastructure cost is significant. No cost estimates or tank sizes were provided in the report. A planning level cost of $2.50 per gallon would result in a capital cost of $2.5 million for a 1-million gallon reservoir.

Other Improvements

The long distance between manholes on some of the drain systems makes maintenance difficult or impossible. The addition of manholes to a spacing of no more than 1,000 feet would improve maintenance capabilities. The cost shown in the CIP is for materials only, and assumes the District staff will perform the work.

Other structural components that may be incorporated in an overall enhancement effort, but are generally classified as maintenance and have not been specifically identified.

4. Long Range Planning

Major projects beyond these priorities are not expected in the next 10 years. The District will re-evaluate its capital plan at least every 2 years and update as warranted. It is possible that priorities may change when re-evaluated.

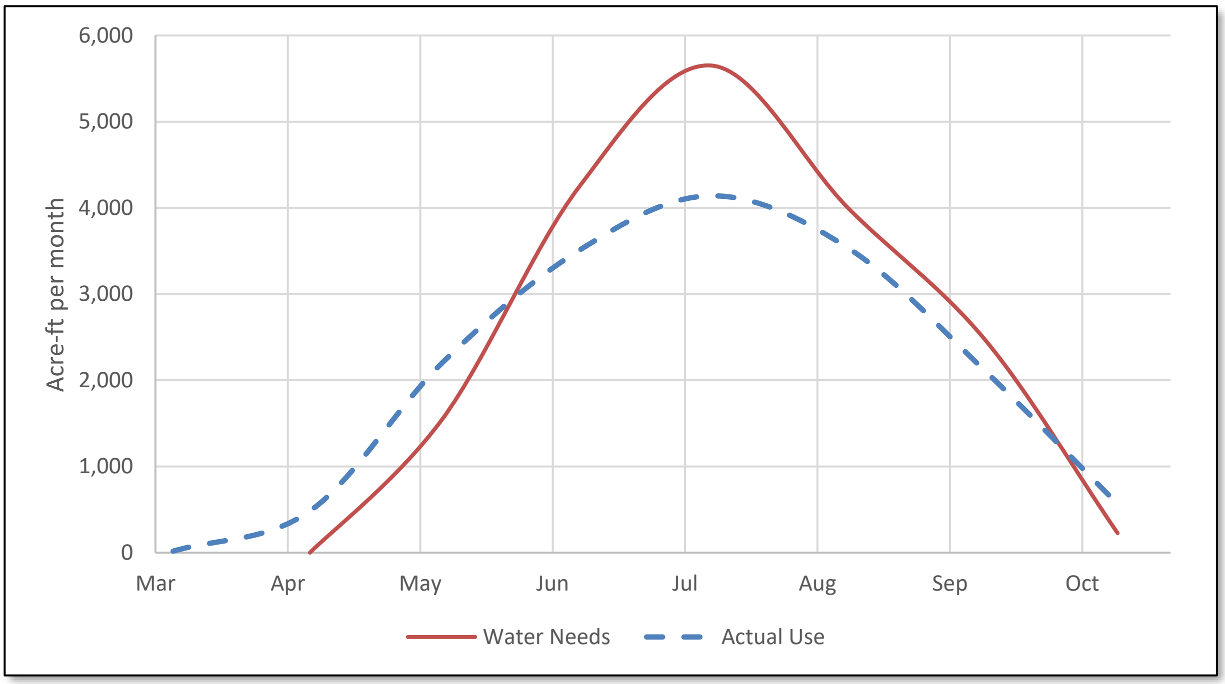
5. Net Water Savings

The District has a 100 percent closed conduit transmission system with exceptionally low leakage rates. There are no evaporative losses or operational spills. No measurable water savings can be expected from physical system improvements.

Improved water efficiencies fall into two primary categories. The first category is gross water savings with residual net benefits. These savings do not directly reduce the total amount of water diverted, but end up putting the water to a more efficient use. The second category includes net water savings that reduce the total amount of water diverted from the lake.

Most of the structural and non-structural improvements in water efficiency are a combination of both gross water savings with residual net benefits and net water savings. **Chart 6-1** shows the relationship of actual average water use as compared to published water needs for typical crops grown in the District. Typical average use indicates that farms tend to front load the season with water use, exceeding crop needs from March to late May. From late May to August, average water use typically is below optimal crop needs. From August to the end of the season, water use roughly equals crop needs. Water needs shown in **Chart 6-1** are based on the evapotranspiration rates shown in the Washington Irrigation Guide for the Chelan area.

Chart 6-1 – Water Needs vs. Water Use



Some of the improvements outlined are aimed at improving the peak supply and enabling the system to meet peak crop needs. These improvements would reduce early season "store up," as well as late season "catch up," and are aimed at compensating for peak demand limitations. Continuing education to farmers would help modify irrigation practices so that irrigation use will more closely match crop irrigation requirements. As illustrated in **Chart 6-1**, irrigation use is typically higher than crop needs early in the growing season. It is estimated that crops are over irrigated during these time periods by as much as 700 acre-feet per month. In mid-season, irrigation use is deficient of crop needs by as much as 1,500 acre-feet per month. Increased capacity might improve fruit production but reduce the net water savings by up to 2,000 acre-feet per year. The residual net benefits may include improved fruit quality, less runoff, and deep percolation. Reducing runoff and deep percolation by up to 1,000 acre-feet per year will result in improved water quality in Lake Chelan, though at a level that might not be measurable.

On-farm sprinkler application efficiency is estimated to be 81 percent. Moderate increases are possible, but more than 85 percent is unlikely barring new technological improvements. Perhaps 500 acre-feet per year could be saved with better on-farm practices.

System shutdowns, whether planned or not, result in water loss by drainout into orchards through farm sprinklers and control valves that have failed to close. Each shutdown results in a loss of approximately 15 acre-feet. The system experiences shutdowns every year, but the number varies from as few as one or two, to as many as ten. Improved automated control systems and replacement or rehabilitation of the hydraulic/pneumatic pump control valves could reduce the drainouts by half, saving approximately 10 to 80 acre-feet per year.

The District's system currently puts water to beneficial use with very little wasted water. While elimination of any wasted water is always a goal, the majority of the proposed projects are for optimal farm production, reduction of power use, replacement of aging equipment, and reduction of operating expenses. The projects proposed in this Plan are not expected to result in a net reduction of water use, but are intended to put the water to its highest and best use at the least cost.

6. Net Energy Savings

The net energy savings from improved water use efficiency is difficult to quantify. Improved irrigation scheduling, combined with system improvements that increase pumping capacities, will change water use patterns throughout the District. If more water per acre is needed on the upper systems, there is a higher energy consumption as water is re-pumped several times to reach the higher elevations.

Construction of new, large regulating reservoirs to allow pumps to run at reduced rates would save electricity. However, in the piping system, friction loss only accounts for 5 to 10 percent of the total energy expenditures. Reducing pump speeds will reduce the friction loss, with an optimistic estimate of 30-percent friction reduction. This may translate to power savings of up to 400,000 kilowatt-hours (kWh) annually, or $40,000. Given that a single 1 MG reservoir may cost $2,500,000, the payback rate for new reservoir construction solely for power savings does not appear feasible.

For the Belzona Supermetalglide mentioned previously in this chapter, lab and field tests (by others) have indicated increased efficiencies of 2 to 10 percent depending on the type of pump and degree of wear. The estimated savings range from $50 to $250 annually per cubic foot per second (cfs) of capacity at each pump. For example, a 3 cfs pump may see $150 to $750 in reduced power costs per year. If all pumps are coated, the total annual electrical savings may be in the range of 300,000 kWh to 1,500,000 kWh, or $3,000 to $15,000. The cost of the Belzona Supermetalglide is quoted at $20 to $35 per square foot of surface area coated (depending on quantity ordered). The cost to coat a pump impeller is difficult to estimate, but may range between $200 and $1,000 depending on size, or $20,000 to $30,000 for all pumps combined. This implies a payback rate of 2 to 10 years depending on effectiveness, assuming the cost for the work is performed by District staff and not a contractor. This is approaching a reasonable cost, and a test application may be warranted.

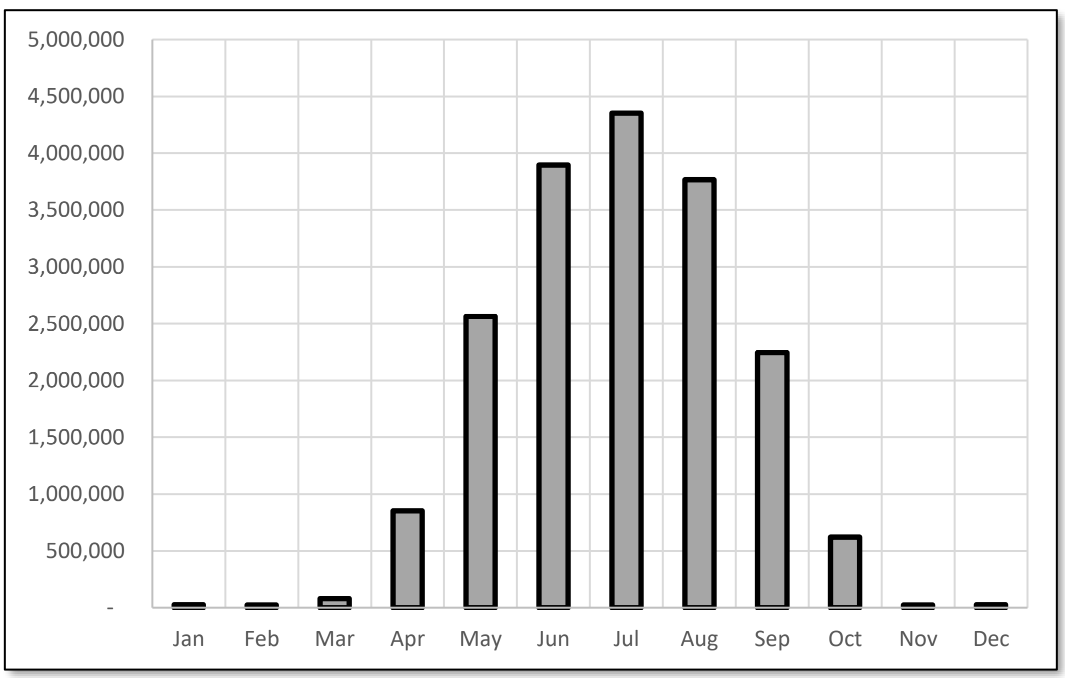
Replacing aging MCCs is expected to improve electrical efficiency, mainly by adding automatic power factor correction or upgrading existing power factor correction capabilities. Currently, power factor correction for the synchronous motors is performed manually at varying intervals. The improvements may increase plant efficiency by 0.5 percent to 1 percent, resulting in electrical savings of 90,000 kWh to 180,000 kWh annually.

The District also may see efficiency gains from pump replacement. For example, the original 1973 test data for pump LC 6 indicated total efficiency (pump and motor) of 79 percent. The 2010 EMP2 Inc. report estimated that this pump had a total efficiency of 74 percent. The new pump installed in 2011 has a total efficiency of 82 percent. This replacement may save between $1,000 and $2,000 per year in power costs. However, the project cost $150,000 to construct, resulting in a payback period of about 100 years. The District completed this project as a maintenance replacement project, not an efficiency project. It is shown here only to provide a comparison of real world performance. Most of the District's pumps are far less efficient than those at the LC Plant, and the payback period should be more favorable at other sites.

The original 1970s era pump selection for Plants A and above may have been based more on durability than optimal efficiency. Additionally, 40 years of operation have worn internal components to the point that pumps appear to be operating currently with efficiencies decreased by 5 to 30 percent from original installation. This translates into an estimated 3,000,000 kWh per year, or $30,000 per year, due to lost hydraulic efficiency. A rough estimate to replace all of the pumps in the District's system is $4,000,000. Replacing all pumps would require a 130-year payback from efficiency gains, which is not financially realistic as a standalone project. However, some highly inefficient pumps may warrant replacement or rebuild. The proposed pump station condition assessment study is expected to refine this evaluation.

Energy use for the year 2015 at the irrigation system pumping plants is shown on **Chart 6-2**.

Chart 6-2 – 2015 Power Use per Month in kWh



7. Socioeconomic Impacts

The implementation of a CIP will result in increased assessments. The social acceptance of these increases will depend upon the percentage increase in each year and the identifiable benefits received by the users. Generally, improvements that result in a better level of service or that are good management practices are socially acceptable.

The capital improvements identified in **Chapter 7** are a combination of system upgrades and system rehabilitation projects. Some of the system upgrades are adding features that will result in an increase in operation and maintenance costs. Most of the system rehabilitation projects will result in lower, long-term operation and maintenance costs. Rehabilitation and maintenance is less expensive in the long run than neglecting routine needs. The net effect in operation and maintenance costs will be very close to zero when adjusted for inflation. The District's long-term goal is to establish a consistent and predictable operation and maintenance program and budget.

Improved irrigation peak demand and water use efficiency could result in both higher fruit quality and quantity. Every dollar of farm revenue is circulated and taxed within the economy many times by the time the product is sold to the consumer.

Lake Chelan has been an area of high growth in resident population and even higher growth in non-resident tourist population. It is generally accepted that growth will occur, but there is a need for planned growth adjacent to existing urban areas. Most people would rather see conversion of agricultural lands to urban uses occur within and adjacent to urban areas rather than rural areas. This will lead to fewer conflicts regarding spray drift, odors, and noises that are generally accepted in agricultural areas but not in urban settings. Chelan County is required to plan under the 1990 Growth Management Act (GMA). The conversion of agricultural lands to urban uses will be managed under GMA guidelines. The District's best method of promoting continued agricultural land use is to provide water reliably and at a reasonable cost. Every project proposed in this Plan supports that goal.

The following two paragraphs were included in the District's 1997 *Water Conservation Plan* and are presented here in their original form. Published data on current crop yield and revenues does not appear to be readily available, but estimates indicate revenues in the range of $2,000 to $10,000 per acre depending on the fruit variety. Therefore, the dollar value estimates presented in 1997 appear to still be valid.

> External economics are difficult to quantify or qualify. Looking at the apple industry alone, a five percent increase in net income would equal approximately $2,000,000 at the farm level. This could result in additional employment in the packing sheds and improved sales at the agricultural support service industries. An economic analysis of the Columbia Basin Project entitled "Regional Economic Development Analysis of Alternative Plans for Continued Development" attempts to quantify the external impact of additional farm production. This report, done by the Bureau of Reclamation in 1987, establishes local and state output multipliers that estimate direct, indirect and induced changes in economic activity.
>
> These models tell us that for each dollar of additional farm income, the local economy will improve by $1.74. Therefore, the economic output of the local area will improve by approximately three and one-half million dollars with the additional two million dollars in farm income. This translates to an additional $4.32 million dollars in economic output on the state level due to the implementation of a plan that produces optimal fruit quality and quantity.

Any reduced diversions from Lake Chelan itself will have little economic impact. The total water savings will impact lake levels less than 1 inch. Total water yield of the Lake Chelan basin already exceeds power generating capacities and will generally result in only an incremental increase in spills to the Columbia River. Although any increase is a net benefit, it is not a level that will be accountable on the Columbia River system. The social benefits of conserving water have a greater impact than the economic benefits. Irrigated agriculture in the Chelan Basin will improve its image among residents and visitors by demonstrating this kind of good stewardship. The agricultural community wants to do its part to maintain and even improve the water quality of Lake Chelan. Implementing projects that increase efficiency will demonstrate a greater social awareness and will benefit the public.

8. Transferring Net Water Savings

The District does not currently anticipate net water savings in the current planning period. There are some possible future changes that could result in lower water needs.

- Technological advances in on-farm application.
- Conversion of high water use crops to lower water use crops.
- Conversion of agricultural lands to other uses.

Should events precipitate a reduction in water needs, the District is willing to negotiate with the Washington State Department of Ecology and other local water users for release of net water savings, conditioned on new or existing laws and contracts.

It should be recognized that if weather warming trends continue, crop water needs will increase.

9. Wetlands

There are no associated wetlands created by District facilities. Water efficiency gains that reduce runoff and deep percolation will mean reduced flows in the District drains. Effectively, all District drains are buried, enclosed pipelines that carry water directly to Lake Chelan or the Wapato, Roses, and Dry Lakes system and on to Lake Chelan. The preferred improvement and rehabilitation plan will have no measurable effect on any wetlands identified or verified on the National Wetlands Inventory. The existing pressurized system is not susceptible to unnoticed leaks that might contribute to the creation of an associated wetland. Leaks on high pressure lines are too erosive to remain unnoticed. It must also be restated that the District's system is a totally enclosed system with no operational spills. All water diverted from Lake Chelan is delivered on-farm through metered deliveries.

10. Water Quality Impacts

Past and current water quality testing information can be found in **Chapter 3**.

Conversion of agricultural lands to urban lands may only marginally improve phosphorus loading on Lake Chelan. Stormwater runoff from urban areas are estimated to contribute 8±4 percent of the total phosphorus and may increase in proportion to the same decrease from agriculture when the conversion of lands takes place.

Water quality benefits will accrue for Lake Chelan if runoff and deep percolation from agricultural lands is reduced. Agricultural contributions of nitrogen, phosphorus, sediments, and pesticides will be reduced. Most of these inputs travel directly to Lake Chelan through District drains. The natural streams in the area receive very small contributions in flow from agricultural lands. These contributions, if reduced, would only enhance the quality of the natural streams.

The Lake Chelan water quality plans identified in **Chapter 3** outline and identify the need to continue to collect water quality data on agricultural drains in the Chelan Basin. The District has undertaken an extensive water quality monitoring program. This program will give the District the opportunity to monitor progress towards reducing agricultural inputs from inefficient water use.

Chapter 7

FINANCIAL

1. Financial Status

The Lake Chelan Reclamation District's (District) balance sheets for the past 5 years, including lists of current assets, fixed assets, and liabilities, are included in **Appendix E**. The District's only current debt is a repayment contract with the U.S. Bureau of Reclamation (USBR). The $2,660,000 loan has an annual payment of $53,200 and a term of 50 years. The first contract payment was deferred until 1987, so the loan will be paid off in 2036.

The District mails assessments early in the year. The 2017 assessment rate includes a $130 delivery charge per parcel, plus $145 per assessed acre, with a minimum charge set by the Board of Directors. Excess charges are classified as Tier 1 or Tier 2.

- Base charge: Includes 36 inches of water per year.
- Tier 1: $3.79 per acre-inch over 36 inches, up to 42 inches.
- Tier 2: $4.55 per acre-inch over 42 inches.

Table 7-1 – Historical Assessment Rates

Year	Per Acre	Per Parcel	Tier 1	Tier 2
2008	$108.00	$80.00	$2.77	$3.98
2009	$128.00	$90.00	$3.32	$3.98
2010	$128.00	$90.00	$3.32	$3.98
2011	$128.00	$90.00	$3.32	$3.98
2012	$128.00	$90.00	$3.32	$3.98
2013	$128.00	$90.00	$3.32	$3.98
2014	$128.00	$90.00	$3.32	$3.98
2015	$130.00	$100.00	$3.38	$4.05
2016	$140.00	$125.00	$3.66	$4.39
2017	$145.00	$130.00	$3.79	$4.55

Excess charges are billed at one time at the end of each season. Customers can request earlier meter readings to check their water use to date. Excess charges in 2016 totaled $70,121.

Income and expenses are listed in the operating statements in **Appendix E**. Assessment rates and annual assessments are listed together with expenses, including operations and maintenance (O&M) expenses, debt service, reserves, and power costs.

The 2016 assessment rate structure can be broken down primarily into the categories of capital improvements, construction fund, power expenses, debt service, and O&M. The assessment breakdown can be approximated as shown in **Table 7-2**.

Table 7-2 – Approximate 2016 Assessment Breakdown

	Per Parcel	Per Acre
Capital Improvements	$1.57	$1.76
Construction Fund	$13.33	$14.93
Power Expenses	$26.29	$29.44
Debt Service	$5.65	$6.32
O&M	$78.16	$87.54
Total	$125.00	$140.00

Capital improvements include office equipment purchases, field equipment purchases, and rehabilitation of pumps and reservoirs. The Construction Fund is set aside for future capital improvements. Power expenses include general power consumption for the buildings, as well as payment of the District's power contract with the USBR and wheeling charges to Chelan County Public Utility District (PUD) No. 1.

The Debt Service to the USBR is for the initial construction repayment contract. The 50-year contract began in 1986 after a 10 plus year development period, and has a $53,200 annual payment, with a scheduled payoff in the year 2036. The District maintains a sinking fund of approximately $80,000 as a condition of the debt service.

The majority of the current assessment is for general O&M expenses, including payroll, fuel, fleet maintenance, pipe and meter repairs, and other miscellaneous expenses.

The District's expenses have exceeded revenues for the last 6 years, with the result being a loss of 30 percent of the reserves since 2010. In response, the District has increased assessment rates. If current trends continue, further rate increases will be necessary just to keep pace with normal expenses.

2. Power Rates

The District pays a unit charge rate per kilowatt-hour (kWh) to USBR for the supply of power and wheeling charges to the Chelan County PUD No. 1 for transmission. The 2015 and 2016 USBR rates were $10.38 and $10.72 per mill, respectively (1 mill equals 1/1,000 kWh). USBR rates are based on the actual cost of power generation, and as such they vary unpredictably per year. Since 2009, the USBR rates have averaged a 4-percent annual increase, though the increase has not been at a constant rate.

Chelan County PUD No. 1 transmission charges to the District appear to have averaged a 4-percent increase per year since 1976, based on the original contract rate. However, from 2012 to 2016 power rates increased an average of 11-percent per year. In 2013, Chelan County PUD No. 1 applied a surcharge of approximately $40,000 per year to fund portions of the District's power transmission infrastructure replacement. This surcharge is expected to remain in place for the next 6 to 10 years.

The District's original power supply contract with USBR and the Chelan County PUD No. 1 was signed in 1972, and amended in 1976. The 50-year contract expires in 2022. It is not known if a new contract will result in changes in power rates or billing structure. The District should investigate potential impacts of a new contract prior to expiration of the current contract. For the purposes of budgeting, no less than a 10-percent annual increase in power charges should be assumed.

3. Capital Improvement Plan

The priority projects identified in **Chapter 6** are shown in the following tables with cost estimates. **Tables 7-3a** and **7.3b** show costs that are classified mainly as operations, maintenance, and specific studies, with scheduled budget estimates. The customer meters are scheduled for a 15-year replacement cycle. The customer pressure reducing valves (PRVs) are on a 20-year replacement cycle. Project costs include 2-percent annual inflation. **Tables 7-3a** and **7-3b** include an estimated cost per assessed acre necessary to directly fund the priority O&M projects. Tables 7-3a1 shows optional projects. The priority project costs come to $44 per assessed acre on average. The Belzona project is listed as an optional project, as a test case is recommended prior to planning for all pumps.

Table 7-3a – Priority Operation and Maintenance Projects (2017-2021)

O&M Projects	Quantity	Per Year	Unit Cost	2017	2018	2019	2020	2021
Maintenance Projects								
Reservoir Painting			n/a		$1,000			
Telemetry/SCADA maintenance		1	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Large Customer Meter Replacement	40 Ea	40 Ea	$3,000	$75,000	$75,000			
Rotating Customer Meter Replacement	700 Ea	50 Ea	$1,300		$66,950	$68,959	$71,027	$73,158
Rotating Customer PRV Replacement	450 Ea	25 Ea	$400		$10,300	$10,609	$10,927	$11,255
Pump motor rebuild	50 Ea	2 Ea	$50,000	$100,000	$103,000	$106,090	$109,273	$112,551
Pump control valve rebuild	50 Ea	2 Ea	$10,000	$20,000	$20,600	$21,218	$21,855	$22,510
Pump plant maintenance		1 Ea	$10,000	$10,000	$10,300	$10,609	$10,927	$11,255
Studies/Management								
Arc Flash (Plants LC & D)	1 Ea	1 Ea		$20,000				
Pump Station Condition and Efficiency				$50,000				
			Total	**$290,000**	**$302,150**	**$232,485**	**$239,009**	**$245,729**
			Per acre	**$45.77**	**$47.69**	**$36.69**	**$37.72**	**$38.78**

Table 7-3a1 – Optional Operation and Maintenance Projects (2017-2021)

O&M Projects	Quantity	Per Year	Unit Cost	2017	2018	2019	2020	2021
Arc Flash	7 Ea	1 Ea	$5,500		$20,000	$20,000		
Pump Station Condition and Efficiency	6 Ea	2 Ea			$82,400	$84,872	$87,418	
PUD Power contract renewal investigation						$20,000		
Belzona pump coating	50	2 Ea	$500	$1,000	$1,000	$1,000	$1,000	$1,000

Table 7-3b – Operation and Maintenance Projects (2022-2026)

	Quantity	Per Year	Unit Cost	2022	2023	2024	2025	2026
Maintenance Projects								
Reservoir Painting		n/a	n/a					$50,000
Telemetry/SCADA Maintenance		n/a	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Rotating Customer Meter Replacement	700 Ea	50 Ea	$73,158	$75,353	$77,613	$79,942	$82,340	$84,810
Rotating Customer PRV Replacement	450 Ea	25 Ea	$11,255	$11,593	$11,941	$12,299	$12,668	$13,048
Pump motor rebuild	50 Ea	2 Ea	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477
Pump control valve rebuild	50 Ea	2 Ea	$22,510	$23,185	$23,881	$24,597	$25,335	$26,095
Pump plant maintenance		1 Ea	$11,255	$11,593	$11,941	$12,299	$12,668	$13,048
Studies/Management								
Comprehensive Plan Update	1 Ea	1 Ea	$50,000		$59,703			
			Total	**$252,651**	**$319,483**	**$267,124**	**$274,688**	**$332,479**
			Per Acre	**$39.88**	**$50.42**	**$42.16**	**$43.35**	**$52.47**

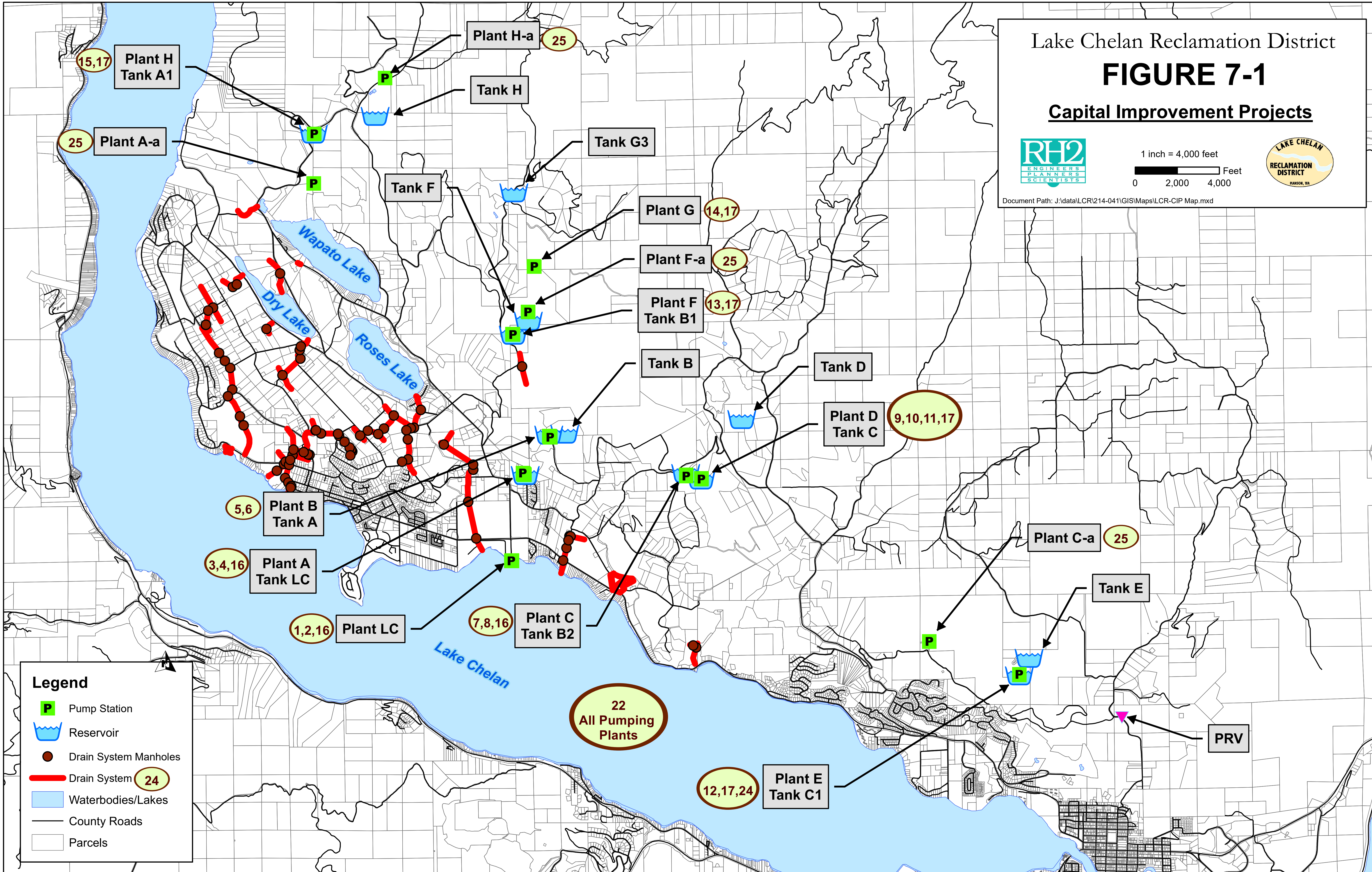
Projects shown in **Table 7-4** are large, one-time projects identified in prior chapters to be completed within the next 10 years.

Table 7-4 – Capital Improvement Projects

No.	Project	Quantity	Unit cost	Total cost
Priority Projects				
1	PP LC MCC replacement	4,250 hp	n/a	$1,313,000
2	PP LC VFD installation	2 Ea	$175,000	$350,000
3	PP A MCC replacement	4,100 hp	n/a	$1,427,000
4	PP A VFD installation	2 Ea	$100,000	$200,000
5	PP B MCC replacement	1,650 hp	n/a	$1,313,000
6	PP B VFD installation	1 Ea	$85,000	$85,000
7	PP C MCC replacement	1,400 hp	n/a	$1,199,000
8	PP C VFD installation	1 Ea	$85,000	$85,000
9	PP D MCC replacement	775 hp	n/a	$298,000
10	PP D VFD installation	1 Ea	$30,000	$30,000
11	Pump D-3 replacement	125 hp	$50,000	$50,000
12	PP E MCC replacement	400 hp	n/a	$240,000
13	PP F MCC replacement	600 hp	n/a	$249,000
14	PP G MCC replacement	160 hp	n/a	$231,000
15	PP H MCC replacement	250 hp	n/a	$133,000
16	Replace relift station control panels (LC, A, B)	1 LS	$220,000	$220,000
17	Replace relift station control panels (Others)	6 Ea	$60,000	$360,000
Optional Projects				
21	Steel service line replacement	17,000 ft	$15	$255,000
22	Install pump discharge manual valves	30 Ea	$10,000	$300,000
23	Add drain system manholes	20 Ea	$4,000	$80,000
24	PP E replace communications	1 Ea	$30,000	$30,000
25	Install booster station control panels	4 Ea	$60,000	$240,000

The projects in **Table 7-4** are also shown on **Figure 7-1**.

A proposed schedule for the projects identified in **Table 7-4** is shown in **Table 7-5**. This schedule will be reviewed periodically by the District Board and revised as needed based on a review of funding sources and public outreach to discuss rate increases.



Lake Chelan Reclamation District
FIGURE 7-1
Capital Improvement Projects
RH2 ENGINEERS PLANNERS SCIENTISTS
1 inch = 4,000 feet
Feet
0
2,000
4,000
LAKE CHELAN RECLAMATION DISTRICT
Document Path: J:\data\LCR\214-041\GIS\Maps\LCR-CIP Map.mxd
15,17
Plant H
Tank A1
Plant H-a
25
Tank H
25
Plant A-a
Tank G3
Tank F
Plant G
14,17
Plant F-a
25
Plant F
Tank B1
13,17
Tank B
Tank D
Plant D
Tank C
9,10,11,17
Wapato Lake
Dry Lake
Roses Lake
5,6
Plant B
Tank A
3,4,16
Plant A
Tank LC
Plant C-a
25
Tank E
1,2,16
Plant LC
7,8,16
Plant C
Tank B2
Lake Chelan
22
All Pumping
Plants
PRV
12,17,24
Plant E
Tank C1
Legend
Pump Station
Reservoir
Drain System Manholes
Drain System
24
Waterbodies/Lakes
County Roads
Parcels

Table 7-5 – 10 Year Capital Project Schedule

No.	Description	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1	PP LC MCC replacement			$1,434,751							
2	PP LC VFD installation			$382,454							
3	PP A MCC replacement					$1,654,284					
4	PP A VFD installation					$231,855					
5	PP B MCC replacement						$1,567,791				
6	PP B VFD installation						$101,494				
7	PP C MCC replacement							$1,474,619			
8	PP C VFD installation							$104,539			
9	PP D MCC replacement								$377,497		
10	PP D VFD installation								$38,003		
11	Pump D-3 replacement			$50,000							
12	PP E MCC replacement									$313,146	
13	PP F MCC replacement									$324,889	
14	PP G MCC replacement										$310,445
15	PP H MCC replacement										$178,741
16	Replace relift station control panels (LC, A, B)	$220,000									
17	Replace relift station control panels (Others)		$190,962	$196,691							
	Total	**$220,000**	**$190,962**	**$2,063,896**	**$0**	**$1,886,139**	**$1,669,285**	**$1,579,158**	**$415,501**	**$638,034**	**$489,186**

4. Financing Plan

Implementing the improvement and rehabilitation plan will take a combination of federal, state, and local dollars. Federal funding may come in the form of grants to the District for both conservation demonstration projects and implementation projects. USBR currently has a grant program called WaterSMART with funds available for projects achieving the specific goals of increasing electrical efficiency, reducing water use, and/or improving the environment.

Local funding will come directly out of assessments. Recent assessment rate increases have only just kept pace with inflation and have not been sufficient to build reserves for capital projects. Grant money is much less available than in the past. The budget projections presented herein assume that all money for the 10-year capital project plan will come from 5 bond sales at 2-year increments. Assuming 20-year financing at 4.5-percent interest, 1.5-percent finance sale fee (included in the payments), and 3-percent inflation, the total cost to bond all priority capital projects is approximately $14 million. The resulting amortization schedule is shown in **Table 7-6**.

Table 7-6 – CIP Bond Financing Amortization Table

Bond sale date	USBR 1987	2018	2020	2022	2024	2026	Annual payment
Bond amount	$2,660,000	$0	$2,094,9854	$3,608,755	$2,024,579	$1,144,128	
2019	$53,200						$53,200
2020	$53,200		$159,037				$212,237
2021	$53,200		$159,037				$212,237
2022	$53,200		$159,037	$273,969			$486,206
2023	$53,200		$159,037	$273,969			$486,206
2024	$53,200		$159,037	$273,969	$153,702		$639,908
2025	$53,200		$159,037	$273,969	$153,702		$639,908
2026	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2027	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2028	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2029	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2030	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2031	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2032	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2033	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2034	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2035	$53,200		$159,037	$273,969	$153,702	$86,860	$726,768
2036			$159,037	$273,969	$153,702	$86,860	$673,568
2037			$159,037	$273,969	$153,702	$86,860	$673,568
2038			$159,037	$273,969	$153,702	$86,860	$673,568
2039			$159,037	$273,969	$153,702	$86,860	$673,568
2040				$273,969	$153,702	$86,860	$514,531
2041				$273,969	$153,702	$86,860	$514,531
2042					$153,702	$86,860	$240,562
2043					$153,702	$86,860	$240,562
2044						$86,860	$86,860
2045						$86,860	$86,860
2046						$0	$0

Table 7-7 shows one possible schedule for assessment rate changes over the next 30 years to fund all identified priority projects by purchasing bonds every two years for the next 10 years. The assessment per-parcel is increased by 5-percent every year to keep pace with the increased cost of normal operating expenses. The assessment per-acre is increased to cover the remaining costs which include the following:

- Capital project debt service.
- Develop and maintain 90 days of cash-on-hand to cover normal expenses during off-revenue periods.
- Develop and maintain a sinking fund to cover 1 year of debt service payments.
- After 10 years, new capital projects paid with cash rather than financing.

The total assessment rate to fund the program could reach $212 per parcel and $319 per acre in 10 years, and $345 per parcel and $425 per acre in 20 years. This is only one of many possible schedules for rate increases.

In **Table 7-7**, General Operations Expenses include wages, benefits, office expenses, and power charges. General Operations O&M includes annual maintenance and projects listed in **Tables 7-3**.

For the budget projections, we have assumed the following annual increases.

- Power rates increase at 10 percent per year.
- Power usage increase at 1 percent per year for new irrigation acreage, and temperature increases.
- General operations increase at 3 percent per year for inflation, wages and benefits.
- Capital project increase at 3 percent per year for inflation. (The Engineering News Record building cost index and construction cost index have averaged 3 percent per year since 1997).

Table 7-7 – Budget Forecast

	General Operations		Capital Projects		Total Expenses	Assessments		Revenues			Required Bond Reserves	Net Position (EOY cash)	
Year	Expenses	O&M	Project Cost (1)	Bond Payment		Per parcel	Per acre	Per parcel	Per acre	Total		Actual	Minimum required
2017	$790,000	$290,000	$0	$53,200	$1,133,200	$130	$145	$297,310	$918,720	$1,216,030	$81,000	$919,000	$360,419
2018	$838,020	$302,150	$220,000	$53,200	$1,193,370	$137	$170	$312,176	$1,077,120	$1,389,296	$81,000	$1,114,926	$362,138
2019	$890,156	$232,485	$190,962	$53,200	$1,175,840	$143	$195	$327,784	$1,235,520	$1,563,304	$81,000	$1,502,389	$370,933
2020	$946,825	$239,009	$2,063,896	$212,237	$1,398,071	$150	$210	$344,173	$1,330,560	$1,674,733	$293,237	$1,779,052	$637,967
2021	$1,008,491	$245,729	$0	$212,237	$1,466,457	$158	$223	$361,382	$1,412,522	$1,773,905	$293,237	$2,086,499	$654,829
2022	$1,075,665	$252,651	$1,886,139	$486,206	$1,814,522	$166	$237	$379,451	$1,499,534	$1,878,985	$567,206	$2,150,962	$1,014,623
2023	$1,148,915	$319,483	$1,669,285	$486,206	$1,954,605	$174	$251	$398,424	$1,591,905	$1,990,329	$567,206	$2,186,686	$1,049,164
2024	$1,228,871	$267,124	$1,579,158	$639,908	$2,135,904	$183	$267	$418,345	$1,689,967	$2,108,312	$720,908	$2,159,094	$1,247,569
2025	$1,316,230	$274,688	$415,501	$639,908	$2,230,826	$192	$283	$439,262	$1,794,068	$2,233,331	$720,908	$2,161,599	$1,270,975
2026	$1,411,763	$332,479	$638,034	$726,768	$2,471,009	$202	$301	$461,225	$1,904,583	$2,365,808	$807,768	$2,056,399	$1,417,058
2027	$1,516,327	$340,503	$489,186	$726,768	$2,583,598	$212	$319	$484,287	$2,021,905	$2,506,192	$807,768	$1,978,993	$1,444,819
2028	$1,561,817	$350,718	$250,000	$726,768	$2,889,303	$222	$339	$508,501	$2,146,455	$2,654,956	$807,768	$1,744,646	$1,520,199
2029	$1,608,672	$361,239	$257,500	$726,768	$2,954,179	$233	$360	$533,926	$2,278,676	$2,812,602	$807,768	$1,603,069	$1,536,196
2030	$1,656,932	$372,077	$265,225	$726,768	$3,021,001	$245	$382	$560,622	$2,419,043	$2,979,665	$807,768	$1,561,733	$1,552,672
2031	$1,706,640	$383,239	$273,182	$726,768	$3,089,828	$257	$405	$588,653	$2,568,056	$3,156,709	$807,768	$1,628,614	$1,569,643
2032	$1,757,839	$394,736	$281,377	$726,768	$3,160,720	$270	$410	$618,086	$2,597,760	$3,215,846	$807,768	$1,683,740	$1,587,123
2033	$1,810,574	$406,578	$289,819	$726,768	$3,233,739	$284	$415	$648,990	$2,629,440	$3,278,430	$807,768	$1,728,432	$1,605,128
2034	$1,864,891	$418,776	$298,513	$726,768	$3,308,948	$298	$420	$681,440	$2,661,120	$3,342,560	$807,768	$1,762,044	$1,623,673
2035	$1,920,838	$431,339	$307,468	$726,768	$3,386,413	$313	$420	$715,512	$2,661,120	$3,376,632	$807,768	$1,752,262	$1,642,774
2036	$1,978,463	$444,279	$316,693	$673,568	$3,413,003	$329	$425	$751,288	$2,692,800	$3,444,088	$673,568	$1,783,347	$1,515,130
2037	$2,037,817	$457,607	$326,193	$673,568	$3,495,186	$345	$425	$788,852	$2,692,800	$3,481,652	$673,568	$1,769,814	$1,535,394
2038	$2,098,952	$471,336	$335,979	$673,568	$3,579,834	$362	$425	$828,295	$2,692,800	$3,521,095	$673,568	$1,711,074	$1,556,267
2039	$2,161,920	$485,476	$346,058	$673,568	$3,667,022	$380	$425	$869,709	$2,692,800	$3,562,509	$673,568	$1,606,561	$1,577,765
2040	$2,226,778	$500,040	$356,440	$514,531	$3,597,789	$399	$420	$913,195	$2,661,120	$3,574,315	$514,531	$1,583,087	$1,401,657
2041	$2,293,581	$515,041	$367,133	$514,531	$3,690,287	$419	$415	$958,854	$2,629,440	$3,588,294	$514,531	$1,481,095	$1,424,465
2042	$2,362,389	$530,492	$378,147	$240,562	$3,511,590	$440	$410	$1,006,797	$2,597,760	$3,604,557	$240,562	$1,574,062	$1,106,433
2043	$2,433,260	$546,407	$389,492	$240,562	$3,609,721	$462	$405	$1,057,137	$2,566,080	$3,623,217	$240,562	$1,587,558	$1,130,630
2044	$2,506,258	$562,799	$401,177	$86,860	$3,557,094	$485	$400	$1,109,994	$2,534,400	$3,644,394	$86,860	$1,674,858	$963,951
2045	$2,581,446	$579,683	$413,212	$86,860	$3,661,201	$510	$395	$1,165,494	$2,502,720	$3,668,214	$86,860	$1,681,871	$989,622

(1) Starting in 2028, assumes $250,000 per year (annually inflated) in capital replacement projects, paid with cash.

5. Depreciation Funding

The District maintains a Construction Fund, but does not specifically fund original utility plant depreciation as an expense. RH2 Engineering, Inc. provided a plant life and depreciation estimate for the irrigation system in 2016, which is included in **Appendix L**. The evaluation estimated a total utility plant replacement value of $78,000,000. For comparison, using the Engineering News Record construction cost index (CCI) multipliers and the original 1975 construction cost of $18,778,000, a replacement value could be estimated as follows:

$18,778,000 x 10,300 (2016 CCI) ÷ 2,212 (1975 CCI) = $87,438,246.

This is presented only to show the 2016 estimate of $78,000,000 is within a reasonable level of accuracy. The 2016 evaluation concluded that straight line depreciation based on current replacement value is approximately $940,000 annually.

The expectation is that the assessment schedules shown in **Table 7-7** would be followed, replaced with the depreciation expense after completion of the 10-year projects, and financing paid off. Depreciation funding in Table 7-7 is currently shown at $250,000 per year after 2027 because much of the anticipated long-term depreciation is in the pipelines, which may have a longer life than assumed in the 2016 evaluation. This depreciation funding should be re-evaluated every few years and may need to be increased. At $250,000 per year, the depreciation expense would require $40 per acre revenue. The District currently supports the Construction Fund at a rate of approximately $20 per acre. To fully fund depreciation, the Construction Fund would require a permanent increase of $148 per acre ($940,000 ÷ 6,336 acres), with annual inflation adjustments.