Lower Nipit Improvement District

(LNID) Letters Patent 1965

160 Twin Lake Road, Kaleden V0H1K0

TWIN LAKE LANDS | WATER LEVELS & HISTORICAL DATA | 1937 – 2022

DECEMBER 2022

PREFACE / EXECUTIVE SUMMARY

This document is to clarify the 1973 Preliminary Report on "Control of Surface Levels on Twin Lakes" by J. Botham of BC Lands & Forests, Kelowna Water Rights Branch and to update by adding the 55 years of LNID history and water records. Challenges for Sustainable Water in the Twin Lake Basin become evident. To add confusion the waterway is in 3 different political jurisdictions (RDOS Area G, I & C) of the local Regional District. **Is there a mitigation strategy for the repeated flood & drought cycles?** Ground water levels to the Twin Lake Area follow what happens in Twin Lake (a canary in the coal mine). The surface water (lakes, rivers and streams) is hydraulically connected to the ground and alluvial aquifer #261 making the Twin Lake levels very important. The water history from 1939 to 2022, water licenses and works are reviewed in the following pages.

A pattern of neglect and misconceptions of the Twin Lake Waterway persists. Our area Dam Supervisor, Michael Noseworthy, in a letter to 2 Ministry offices in 2018 ignored the waterway evidence and stated that Twin Lake is a dead end "Endorheic Lake". This statement was made without considering the history of the early ranchers. There is **a possible restoration solution** but, the BC Province **not** the LNID must take a leadership role to bring together all stakeholders who benefit from sustainable water in the Twin Lake Basin.

The March 2020 BC Partnership for Water Sustainability stated, "Restoring Nature Builds Resilience" and there are benefits when "Transforming Eco Liability into Eco Assets".

Good water stewards understand the importance of their water source, water use, the watershed and the role it plays in economics, local agriculture and community dynamics.

Respectfully Submitted on behalf of the Lower Nipit (Twin Lake Land) Improvement District,

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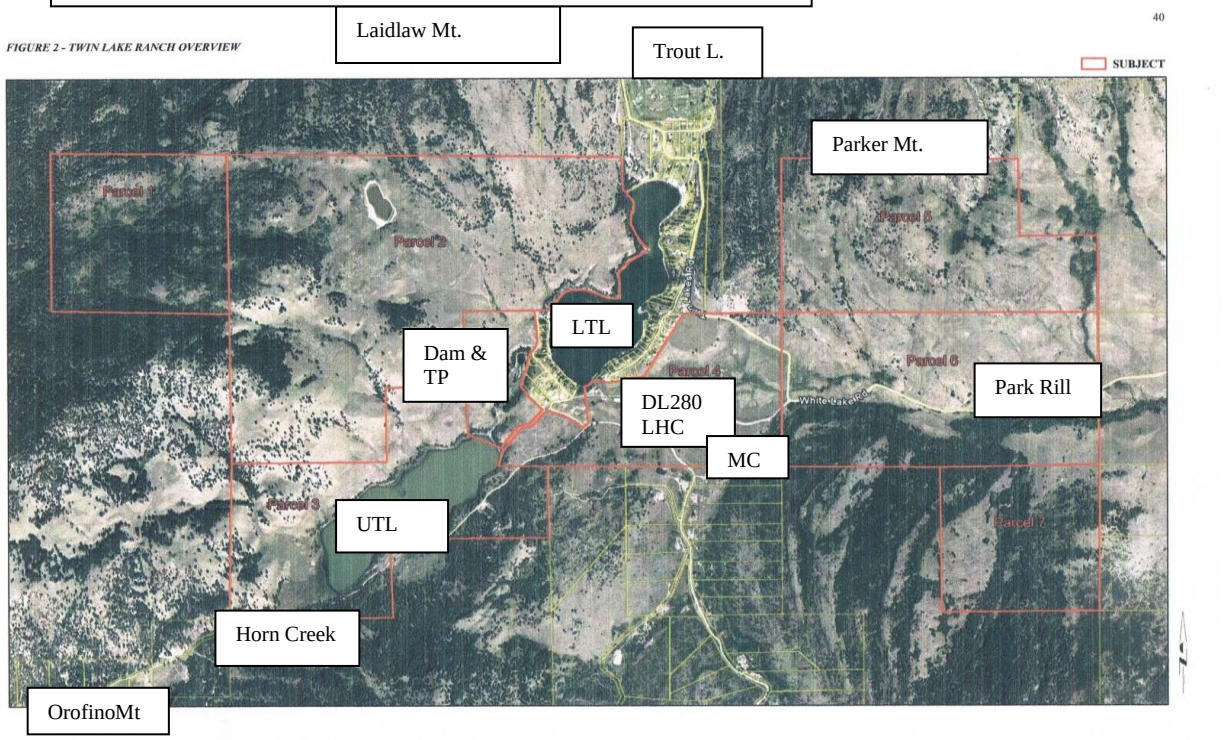
Fig 1 Parcels, District Lots of Twin Lake Waterway



Parcel 3 is in DL 427, Parcel 4 is in DL 280. On the south corner of DL 427 are the Twin Culverts of Horn Creek as it exits Orofino Mt. and moves to Upper Twin Lake (UTL). From UTL water moves to the earthen dam with a slide culvert, then on to the Turtle Pond (TP) and under the Eastview Rd. culvert to Lower Twin Lake (LTL). From LTL water moves in 2 directions around Parker Mt. – #1. NW by ground water and aquifer #261under the Twin Lake Golf Course, to Trout Lake and Marama Creek or #2. NE to "The Parc" of DL 280 in Lower Horn Creek (LHC) to meet Myers Creek (MC) also known as Park Rill & is joined by 4 other creeks to eventually enter Sportsman Bowl & onto the Okanagan River. .

1.0.0 PURPOSE

It is economically prudent to restore wetlands; to recognize the Twin Lake Waterway with the original overflow outlet which requires restoration at a level according to the present lakefront development. This is necessary to ensure sustainable water. There can be no increase water use without ensuring sustainable water. This semi- arid, ground water limited area is a sensitive eco system. Environment Canada states, "Sustainable development is about meeting the needs of today without compromising the needs of future generations".
The Precautionary Principle, "taking preventative action in the face of uncertainty" must be applied. The South Okanagan Twin Lake Basin is located at the height of land between Keremeos & Kaleden. It is rich with species at risk. There is open land but limited water.

1.1.0 HYPOTHESIS

The only possible solution for sustainable water in the Twin Lake Basin and aquifer is by **restoring the Twin Lake north & south wetlands along with a gravity-feed, gate controlled pipe** similar to the pipe placed in the Lower Horn Creek outlet in 1951 by the Ministry of Transport for the lakefront trail to

crossing and to help control irrigation to DL 280 & 281. The pipe was removed about 1962 when water was low, making the pipe unnecessary at the time. A new owner, Wassman, found a gas-powered pump in the lake convenient. The rancher filled the ditch and overflow outlet to Lower Horn Creek. Restoring wetlands would slow, sink and store wet year spring run-off over aquifer #261 in DL 280. There is some additional water storage available around Upper Twin Lake which belongs to the Nature Trust of BC. There are no residences around Upper Twin Lake and only one Lower Twin Lake lakefront residence in the 320 acre "Parc" wetland on DL 280. This one residence is adjacent to the Lower Horn Creek bed.

The affected stakeholders who require sustainable water, the LNID, and the province must work together. Leadership is needed. Since the Province owns the water, the province must lead to protect their water. All stakeholders must understand the importance of a solution for sustainable water and be willing to co-operate and participate. Water is important, not just for man's existence but also for this sensitive ecosystem and the many species at risk. In 1959 the site for the Federal Dominion Radio Astrophysical Observatory (DRAO) was chosen near Twin Lake, just over Parker Mt. in a valley where it is important to maintain restricted electrical interference.

1.2.0 OUTLINE OF TWIN LAKE'S HISTORY

1.2.1 TWIN LAKE RANCHERS & WATER CONCERNS

In 1904, water concerns became apparent when the first water licence was issued to Charles des Blois Green, an English surveyor, who purchased the Upper Twin Lake (UTL) Ranch. Mr. Green and his family were initially summer residents but became permanent after WWI. They owned the Upper Ranch until about 1970. The remains of the Green's water reservoir are still evident along the shore of UTL.

By the late 1930s, the Green's Upper Twin Lake Ranch surrounded UTL and Lower Twin Lake (LTL) had two ranches (the Lower and Middle Ranch), both owned by Mr. D.L. Sutherland and his two sons. In 1939, Mr. Sutherland purchased the Learne's hayfield along the east side of Highway 3A which is now Twin Lake Golf Course (TLGC).

From 1945 to 1974, the North LTL Ranch became a famous dude ranch called Twin Lake Guest Ranch which entertained many international visitors. In 1960, the sons of D.L. Sutherland, owners of the Lower (Guest) and Middle Twin Lake Ranch (both on LTL), subdivided their lakefront property along the south bay of LTL to create recreational lots. The Sutherlands sold their Middle Ranch and the hayfield along Highway 3A to Mr. R. Wassman.

The three 1960 Twin Lake ranchers were Sutherlands of the lower "Twin Lake Guest Ranch", Green of the Upper Twin Lake Ranch around the UTL, and Wassman of the Middle Ranch which **included a critical piece of LTL lakeshore, the overflow outlet called Lower Horn Creek** and the low land called "The Parc" in DL 280. The three ranchers struggled with their water supply, which was complicated by droughts, floods, water diversions, water storage, an earthen dam (1948), water licences and gravity-feed irrigation. In 1962 the new rancher, Mr. R. Wassman of the Middle Twin Lake (TL) Ranch, observed a low water level and proceeded to plug the gravity feed pipe and fill Lower Horn Creek with 21 ft. of fill.

After only 4 years the 18 lakefront property owners approached the province about low water levels. In 1965, drought and flood concerns prompted the BC Province to form a **Land Improvement** District (LNID) for the LTL lakefront property owners. **The province recognized a growing problem.**

In 1970, Wassman began constructing the nine-hole TLGC, but he passed away in 1971. The 9 Hole TLGC was completed in 1976 by Mr. Shillitto. A 1970s developer, Gabriola Enterprises, purchased all of

the Twin Lake ranches *except* the northern dude ranch and the lakefront recreational properties. The developer planned to build a large resort with 4,000 dwellings along the southern aspect of Lower Twin Lake. After nine years, the developer sold to Art and Thelma Krieger. This Agricultural Land Reserve (ALR) could not be developed. From 1970 until 1990, the Kriegers owned the down gradient White Lake Ranch, all of the land around UTL, the water licence for the earthen dam, the Parc Land (DL 280) and much of the land around LTL except the Dude Ranch and the LTL lakefront recreational lots. In 1990 Mr. Jim McPherson, a Vancouver real estate investor, purchased the Kriegers' Twin Lake Ranch which he named Twin R Ranch. In 2011 The Nature Trust of BC purchased Twin R Ranch for the value of grassland conservation.

1.2.2 RANCH WATER MANAGE BY KRIEGERS TO 1986. DRY YEARS TO 1996

The Kriegers were active ranchers and managed the water satisfactorily on both Upper and Lower Twin Lake while successfully providing hay land for their cattle. Spring run-off from Horn Creek was stored behind the earthen dam to back water up onto the DL 427, where the old, large barn still exists on the southern shores of UTL. The water was stored until June 30 and then released from UTL, as per their water licences. Storing water in the spring behind the 1948 earthen dam caused flooding/watering of the south pasture of UTL. Cattle had good hay until about mid-July when they were moved to the Parc area of DL 280. The stored UTL water was released by June 30 from UTL to LTL and then pumped from LTL to irrigate DL 280. This gave the rancher two watered fields by storing and releasing water. This system worked well during average freshet years. The Krieger's land also included the down gradient White Lake Ranch. With a planned sale in 1986, Krieger's stopped their surface water irrigation to the Parc. A 30% water loss occurs with irrigation due to evaporation & 30% loss to plant growth. 1987 to 1995 was a dry year water cycle so that no water management was required until the wet years of 1996-1999.

1.2.3 NO WATERSHED MANAGEMENT REQUIRED AFTER KRIEGERS 1986-1996

In 1986, an 18-hole golf course opened with irrigation from deep wells into aquifer #261. Ranch Irrigation was replaced by Golf Course irrigation. In 1990, Krieger's sold to an investor, Jim McPherson. In the wet years of **1996 to 1999, with no ranch irrigation the LNID eventually enacted their water licences.** A Statutory Right of Way (SRW) was surveyed across the Parc of DL 280 and the LNID installed a 6 in. pipe with a low-pressure electric pump at the site of the Lower Horn Creek overflow outlet from LTL. Mr. McPherson gave his permission but would not sign the SRW legal documents. In 1997 to 1998, because of a very large spring run-off, the LNID arranged for a licence to divert ½ the water flow to the next S. White Lake Valley filling a natural hollow which is now developed. Dry years followed from 2000 until 2009 with no surface spring run-off water reaching the Upper Twin Lake 2007 to 2009. Many residents lost water in their well & lake intakes by 2009. **Water use was greater than water-in!** Well levels were down – some dropped 2 to 3 meters. The Lake could not be managed since there was no water storage and even the Turtle Pond was completely dry.

Mr. McPherson had the water licence for the earthen dam. He closed and locked the slide culvert at the Upper Twin Lake outlet to attempt to make the UTL larger in the low snowpack years. In 2008, the outlet of UTL was deliberately blocked with rubble. The Ministry allowed this blockage and breach of McPherson's water licence, telling the LNID that the Ministry office was "too busy to research this file". With hindsight McPherson's blocking of the waterway did not affect the lake levels rather it was low snow pack and high water use since the TLGC watered 24/7. In 2007 McPherson advertised his 800-hectare Ranch for sale in 5 large parcels. The Twin R Ranch did not sell with the downturn in the economy. The Twin Lake Golf Course sold in Jan. 2008. During 2007 and 2008 the Golf Course

irrigation was 24/7 even though the snowpack was low. With no spring run- off water into the system and heavy water use by the Golf Course, the Twin Lake water level **dropped to a low of 7.5 vertical ft.**

2010 to 2020 were wet years with the exception of 2019 when the snowpack was 81% of Normal (N) **and no surface water reached UTL.** Twin Lake fell by 4 vertical ft. In 2017 with a **snow packs of 150% N and in 2018 a snow pack of 206%N, no overflow** outlet, **no other available diversion**, costly floods occurred. In 2018 the LTL had 8 ft. of flood water and the Emergency Measures Flood cost was over a million dollars. In 1997 the Ministry approved only a low pressure LNID Twin Lake pump which pumps about 3/8 in. in 24 hr., thus in 2017 & 2018 larger diesel pumps were required at the original overflow outlet of Lower Twin Lake to pump 5 vertical ft. of water in 2017 and 14 vertical ft. of water in 2018. In 2019 with no water storage, a low snow pack and no surface water into the water way, there was a renewed concern about sustainable water for the 2 pending developments (208 TLGC dwellings, a TLGC Resort Village and a Marijuana Facility) over aquifer #261. In 2019 recommencement of logging (ceased in 2005) with large new 2017 logging roads in the Watershed will affect the watershed.

The BC Ministry of Environment aquifer information for aquifer #261 has not been updated since 2007 even though several hydro geological studies have been completed since 2007. Several more wells have been drilled and an average of three houses have been built each year including in 2022.

500 head of cattle are along the Twin Lake Waterway which was mostly fenced off in 2016. Cattle consume about 20 US g/day of water and thus must be factored into the water- out calculations.
In 2020 it became popular to invite the public into the Twin Lake Area with proposed easement developments, a Park, and a fishing dock.

1.2.4 SOME BENEFICIAL INITIATIVES 1996-2016

In 1996 the LNID obtained a SRW agreement and installed a pump and 6-inch pipe at the historical overflow outlet site of LTL to divert ¼ to ½ inch depending on the lake size of water per day on the approval of the Ministry of Forests, Lands and Natural Resources Operations Rural Development (MoFLNRORD) into Lower Horn Creek. Flooding was avoided during the very wet years of 1996 to 1999, by the use of the LNID **pump to the north and a south** culvert from Horn Creek with a **ditch to divert water** (1997 to 1998) to the **next White Lake Valley DL 1469s**.

During the dry-year water cycle, 2000 to 2009, less water entered Twin Lake with no surface water in from 2007 to 2009, while water-use increased with the sale of TLGC in January 2008. LTL was pinched between less water-in and more water-out of this hydrologic system.

By 2009, the lake and aquifer levels fell below acceptable levels (well levels had dropped by 2 to 3m.), so that many lost water in their well or lake intakes and the Turtle Pond dried up.

In 2010, with the lake and aquifer #261 at very low levels, a Twin Lake Aquifer Capacity Study was completed by Summit. Summit concluded that only 30-35% of the recharge water should be used and estimated that the maximum water use should be no more than 570 US g/m. The Summit Study was paid for by The Ministry and LNID with the shortfall covered by Okanagan Basin Water Board. In February 2011, two Observation Ground Water Monitoring Wells were drilled at either end of LTL.

The Nature Trust of BC (NTBC) purchased the 800-hectare Upper and Middle TL ranches from McPherson in 2011. The owner of 325 Westview Road and the new owners NTBC signed legal agreements with LNID for the SRWs which are now registered with the BC Land Title Office.

In 2016 the New Water Sustainability Act was released. Commercial wells were to be licensed and domestic wells were to be registered by 2022.

1.2.5 DROUGHT/ FLOODS & Inadequate "Works".

Since the drought of 2007 to 2009 and then the costly floods of 2017 and 2018 on LTL, the LNID have gained increased understanding and realize that UTL and LTL are on a **waterway influenced by events in the watershed above and down gradient.** The Twin Lake is necessary to recharge aquifer #261and is an important source of water for the Okanagan River. Pumping is not adequate, not efficient, not economical, and not safe for the environment.

During 2017 & 2018, UTL and LTL did become one lake, just as we have read in the past early days. One lake explains the early survey maps and the name of Twin Lake. During both floods, no water flowed between the lakes as they were one lake – the system was full and flooding.

By 2019, two development applications were progressing in the Twin Lake Area where water was said to be "overtaxed" by Golder in their 2011 Peer Review.
In 2019 the Green Mountain Medical Health Facility was drawing water from aquifer #261. The large diversion water licence belonging to Nature Trust of BC is still active.

2.0.0 TWIN LAKE WATERWAY FACTS

To make the water history of Twin Lake clear, it is important to use the gazetted and original survey name "Twin Lake". The anecdotal names of Horn & Nipit add to the confusion. Twin Lake is one lake in the spring of the wet years, but 2 lakes called Upper Twin Lake (UTL) and Lower Twin Lake (LTL) with warmer weather and/or dryer water cycles. Historically, the wet & dry water cycle is about 20 years which allows for much distraction, offences and a loss of focus. Twin Lake is part of **an upland "Y" shaped waterway** (hydrologic system) so formed by Orofino, Parker and Laidlaw Mountains in the Horn Creek Watershed. The Twin Lake Waterway is tributary to the Okanagan River along with 4 other creeks. The 2 arms of the "Y" shaped waterway have 2 lakes in common, namely the no name "Top Lake" at 1550 masl & Twin Lake at about 800masl. Arising from the Top Lake the creeks Bear and Horn Creek join on the west face of Orofino Mt. and are then known as Horn Creek which is the main source of surface water supply to Twin Lake & aquifer #261. The "Top Lake" has an overflow outlet culvert crossed by a Forestry Services Road. Horn Creek is ephemeral at the lower elevation where it enters UTL. The flow of Horn Creek depends on the Orofino Mt. winter snow pack and the timing/amount of the spring precipitation.
The Twin Lake NE waterway arm discharges through a land barrier from LTL into Lower Horn Creek to reach Myers/Park Rill Creek which originates from a NE face of Orofino Mt. In the early years, there was an ("**appears to be" according to Botham)** an overflow LTL outlet. The pre 1930 area map, obtained from UBC library archives, shows an ephemeral Lower Horn Creek exiting Lower Twin Lake. This overflow outlet is near the 1960 Middle Twin Lake ranch house. Lower Horn Creek was ephemeral at this land barrier before the man-made waterway excavations, licensed in 1951 in "The Parc" DL 280.
The Twin Lake NW waterway arm from LTL **is** connected by ground water under the Twin Lake Golf Course (TLGC) to Trout Lake which did have a wetland overflow before the #3A Highway was built. Until about 2013 Trout Lake water seeped under Highway 3A. Trout Lake was a healthy, deep little lake teaming with fish & vegetation until the Yellow Lake Highway Improvement dumped tons of debris into a deep hollow near the Trout Lake historical wetland by the highway maintenance yard. Aquifer #261 hugs the shoreline of Trout Lake and is the source of Marama Creek which enters Marron Lake. Marron Lake moves via the Marron River to Skaha Lake.

There is an earthen dam at the UTL outlet with a slide culvert licensed to store 380-acre ft. of water over the 80 acre UTL or 4.9 vertical ft. of water before reaching the concrete spillway. The slide culvert output channel leads to the Turtle Pond (TP) with a drop of only about 1ft. over 1 km. When full the TP spills to LTL in a 24 in. culvert under Eastview Rd. In the mid wet year cycle of **May 2013** UTL was at **797 masl** with LTL at the vertical normal high-water level of **795.6 masl** and Trout Lake was at **764.2 masl.** Ground water seeps from LTL under the TLGC to Trout Lake by hydraulic pressure. Underneath this "Y" shaped waterway is the "Twin Lake" alluvial (sand & gravel) unconsolidated, semi-confined Aquifer #261.
In Feb.1973 the BC Dept. of Lands, Forests and Water Resources released the Preliminary Report on "Control of Surface Levels on Twin Lake" by J. Botham. The Report contains history, some hydrology, recommended lake levels and recommendations for further works.
Both flood & drought affect the Twin Lake Area's water sustainability. There is no other water source available for the Twin Lake Basin. The 2017 & 2018 flood expense could have been better utilized by restoring the overflow gate-controlled gravity- feed pipe and the wetlands both above & below Twin Lake. These measures would help protect down gradient properties and decrease the risk of unsustainable water for the existing Twin Lake Area properties, and ecosystems...

In 2010, the Water Canada Gauges (WCGs) had been lost due to the low water and were reset at:
1. LTL according to the old pipe sill demarcation in a rock on the beach at 325 Westview Rd. which equates to the 1968 hydrometric station of 17.6 ft. or 795.6 masl for the normal high water boundary.
2. At the UTL outlet wooden earthen dam structure - a measurement of stored UTL water and
3. The WCG at the Turtle Pond (TP) was set at "0" on the fence post at the outlet to mark the normal level of the Turtle Pond before water stored. Water begins spilling to LTL when the TP water level reaches .4m on the WCG. These WCGs require maintenance due to structure deterioration, ice/ wind and dislodging.
4. In 2021 LNID installed a data logger to record LTL water levels which is adjusted according to field measurements.

3. EARLY TWIN LAKE WATER LICENCES

Botham listed the following:
1. # 607 in 1904 to Charles de Blois Green from Horn Creek
2. # 1047 in 1911 to Gilbert Taylor for irrigation to DL 280 & 281 from LTL. But by1926 Mr. Taylor had not been able to devise a practical system to transport the water to land & his licence was abandoned
3. # 4192 in 1923 to Gilbert Taylor for 24.5 acre ft. to irrigate 9.8 acres of DL 281.
4. #10471 in 1930 to divert 30 acre ft./year to 18 acres of DL 427 (Green's Upper Twin Lake Ranch), but pumping was too expensive so Mr. Green applied in 1935 to have the licence amended to construct a gravity pipeline from Horn Creek on DL 1469s upstream of UTL to irrigate DL 427.
5. # 10377 in 1938 to Mr. Green – final water licence as the conditional licence #10471 was successful. This diversion pipe is now covered by a slide or excavation **debris but still spills** in the spring to the SW side of the upper DL 427 of the Nature Trust field. This spill happens even when no water runs in the spring in Horn Creek at the DL 1469s culverts and is earlier than the Horn Creek flow through the culverts.
6. 1942 was a heavy run-off so that Green & Sutherland agreed to reduce the flooding of the UTL & increase the low water level of the LTL. Green deepened the outlet of UTL.
7. 1943 &1944 were below average inflow & Sutherland had returned the UTL outlet to what he stated was the normal level.
8. 1946 with increased inflow a dispute between Greens & Sutherlands occurred as Mr. Green stated Sutherland closed the UTL outlet to create a higher elevation – Fairview Water District solved the dispute by assigning a maximum elevation to the UTL water level and the outlet.(The Ministry have not been able to find this elevation).

9. 1947 was low run-off but 1948 was a maximum recorded run-off causing flooding of both Lakes.
10. # 19012 in 1949 the Sutherland Brothers applied to build a 3 ft. high earthen dam to store 200 acre ft. on the UTL. The storage was subject to the previous established UTL high water (the Ministry has not be able to define a high water UTL level). A slide culvert was installed and the water licence states that water maybe stored (culvert closed) from Oct. 1 to Jun 30.
11. #19011 in 1949 the Sutherland Brothers applied to install a pump in the SE corner of LTL to divert 200-acre ft. for the irrigation of 100 acres of DL 280 by pipe & ditch
12. 1951 sudden snow melt caused flooding so the Sutherlands added another pump to divert 15-acre ft. per day beginning May 17. Water was pumped into Lower Horn Creek from LTL. **Sutherlands were told to stop pumping July 18 due to downstream flooding.**
13. # 20605 in 1952 to the Sutherlands to replace #19011 with the added clauses - **water so diverted to be used for irrigation only, the rate of the diverted water will be designated by the Water Rights Engineer** and must not be greater than his designation.
14. # 20605 in 1952 to the Sutherlands (replacing #19012) stated, "to install a 500 ft.15 in. diameter pipe laid in the existing 25ft. deep ditch with a concrete headwall & vertical steel headwall with a vertical steel control gate at the lake end". The pipe was placed and the open portion of the ditch was extended 1200 ft. east to a sump dug in Lower Horn Creek where the irrigation pump was relocated.
15. #20606 in 1952 replaced #19012 for John Stewart, owner of DL 282 & 283. He agreed to build weirs at the pumps of Stewart's re-diversion so to take all the water the Sutherlands could pump.
16. #20605 in 1961 was cancelled by Mr. Wassman owner of Middle Twin Lake Ranch - DL 280 & 281. In a letter Mr. Wassman warned the lakefront LTL property owners that he intended to plug the 15 in. drainpipe & fill in the ditch with 20 ft. of fill to protect his cattle. Mr. Wassman carried out his plan.

4. TWIN LAKES WATER REPORT BY J. BOTHAM, FEBRUARY 1973

Botham concluded that the average annual Twin Lake freshet was 4 to 7 vertical ft. The licensed diversion was 202.7 acre-ft., estimated evaporation was 160.2 acre ft. (18 in.) and estimated seepage was 27.1 acre ft./year. Total irrigation water-use in 1973 was estimated to be 390 acre ft. or 4.6 vertical ft. of Twin Lake water. The **1939 to 1970** water history was documented in the 1973 Botham Report to address concerns around control of high and low water levels in Twin Lake and to outline the possibility of re-establishing the 1951 outlet works. A Bathymetric Map of LTL estimates one inch of water in LTL to be 2,900,074 US gallons.

1937 – 1941 were years with below average run-off.
1942 heavy spring run-off caused flooding of the UTL affecting the UTL resident rancher, Mr. Green. However, LTL was at a low level from the previous 4 years of low spring run-off. Mr. Sutherland, owner of Lower & Middle Twin Lake Ranch, received permission to deepen the outlet channel from UTL to LTL.
1943 & 1944 had below average run-off.
1945 had an average in-flow.
1946 heavy in-flow & Mr. Sutherland owner of the Lower TL Ranch reassured Mr. Green that "the channel had been closed to the original level".
1947 was a low run-off year.
1948 was a **maximum recorded run-off** and flooded both lakes (2 lakes become one Twin Lake as on the original survey).
1948 – 1959 had above average run-off.
1949 - June 2 water licences were issued to the Sutherlands: 1. to construct a 3 ft. high dam at the UTL outlet to store 200 acre ft of water in UTL. This licence was subject to the water level established in 1946 by the Fairview Water District for the UTL and 2. the water licence to install a pump at the NE corner of

the LTL to divert 200 acre ft. of water to irrigate the 100 acres of DL 280 by pipe & ditch (no minimum lake level was stated at this time).
1950's – was a wet weather cycle.
1950 - Caused flood damage so that a gate-controlled gravity feed overflow pipe & ditch was constructed at the natural overflow outlet of Lower Twin Lake to divert excess inflow water to DL 280. Botham stated these works were only to be used for irrigation (of DL 280 & 281), and operated so that the surface level in Lower Twin Lake was reduced without adding to the flood potential of Park Rill.
1951 was another high run-off year with a large snowpack & rapid spring melt causing flooding of the Dude Ranch. Pumping was stopped July 18 due to down gradient flooding.
1952 Sutherlands applied for a sump pump licence to pump water from mid DL 280 to DL 281.
1960s the water level continued to drop in a dry weather cycle so that **no water** reached the LTL overflow pipe outlet. . Mr. Wassman purchased the Middle Ranch in 1960.
1960 LTL was at13.6 ft.
1964 - the overflow pipe had been removed & the ditch had been filled with 20 ft. of fill to protect the cattle. With power to the area in 1965, and low water levels, Mr. Wassman pumped water directly from the Lower Twin Lake to his "Parc" field in DL 280.
1964 & 1965 LTL was only at 13.6 ft.
1966 LTL was at 11.6 ft
1967 LTL was at 10.2 ft. (residents observed over pumping by the Middle Lake rancher, Mr. Wassman).
1968 - a hydrometric station (08NM148) was set near the overflow outlet of LTL so that the normal high water mark was 17.6 ft. (a vertical water level mark). The tree line or initial flood stage or full lake pool is about 19.6 ft. The Province took regular readings at the hydrometric station from April 1st to Sept 30th in 1968 to 1972. There was also a hydrometric station at the confluence of Bear & Horn Creek.
1968 LTL dropped to 7.6 ft.
1969 LTL recovered very slightly.
1970 LTL had minimum inflow and was at the low level of 4.6 ft.
1973 – Botham assigned a low lake level to LTL of 12.6 vertical ft. to prevent excess ranch irrigation.

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5.0.0 DISCUSSION

In 2014 the Horn/Bear Creek confluence had a large washout and was observed by the Ministry of FLNRORD from Vernon. **This large washout has caused continued down gradient erosion** and two more washouts which all require further assessment, stabilizing and repair by the Ministry. Repairs/stabilizing has not been completed as 1st Nation's artifacts were found.

In early May 2018, Bear & Horn Creeks washed out at the confluence and all the way to the culverts at the S. White Lake Rd. The culverts were rebuilt by, the now deceased, land owner Si Siebens. In 2018, after the Horn Creek spring washout, these culverts were blocked with rip-rap (rock rubble) but cleared by a nearby resident. There is a new logging road at the S. end of Grand Oro Rd. competed in 2019. The logging road crosses the "Top Lake" overflow outlet which has a 24 inch culvert under the road. It does not seem that either of these potential offences caused the minimal flow of Horn Creek in 2019. Low snowpack and greater water-out than water- in seem the contributing factors.

There is a window of opportunity for a possible Twin Lake Area sustainable water solution. Since the wet year flooding of 1996-1999, when ½ the freshet was diverted to the next valley; it became evident that a solution to mitigate both the flood & drought was necessary. The LNID has written many letters to BC government officials requesting assistance/leadership. Sustainable water in Twin Lake & the aquifer must be achieved before further development & pending climate change takes effect. The only sensible solution is to restore the original wetlands and the gravity feed gate controlled pipe so that water can be

made to slow, sink and then be stored over aquifer #261. Because of the historical 20 year wet & dry year water cycle the wetlands would only be for a few years (estimated to be about 6 years) out of the 20 years.

There is some water storage available around the UTL on Nature Trust Land and has been used to increase storage successfully in the past. There are no residences around UTL or in the DL 280 "Parc" wetland. The old earthen dam requires a "common sense" safety approach – it is not the Testalinden Dam. The slope from the UTL outlet to the Eastview Rd. culvert is only about 1 ft. over ~1 km. This document, "Twin Lake Lands/Water Levels & Historical Data" provides some incite and understanding of the Twin Lake Waterway and aquifer #261. Some definite freshet patterns are evident, along with abuse of the waterway. Conclusions can be drawn. The Water Canada Gages are difficult to maintain due to ice, wind and the large water level variances. The waterway flows can and must be managed in order to have sustainable water in the Twin Lake Area. At this time, it is impossible to manage the wet years with only a small flow pump. The pump is operated only with the BC Ministry FLNRORD Water Stewardship permission to release water which depends on downstream water levels.

6.*0.0* CONCLUSIION

If the Province and the several stakeholders, who need sustainable water, work together a solution can be achieved. Leadership is needed. The BC Province owns the water; the province should provide the leadership to protect their water. All stakeholders must understand the importance of and the risks to sustainable water and be willing to participate/co-operate. The Twin Lake Area has water storage in the alluvial aquifer #261, but if too much water is removed from the aquifer the ability to store water will decrease due to cementation. Summit in the 2010 Twin Lake Aquifer Capacity Study suggested that only 30 to 35% of the recharge should be used in any given year.

Water is important, not just for man's existence, and property values, but also, for this sensitive ecosystem and the many species at risk found in this upland South Okanagan Area. We repeat the March 2020 Partnership for Water Sustainability statement that "Restoring Nature Builds Resilience" and there are benefits of "Transforming Eco liability into Eco Assets". A million dollar 2017 flood event and about 3 million dollar 2018 flood were both managed by Emergency Measurers. Large diesel pumps and diesel fuel tanks were placed on the edge of LTL - a huge liability. The 8 ft. x 300m sandbag and heco bin dike to hold back the force of two 80+ acre ft. lakes was very dangerous. Downstream had large areas of erosion from the effects of the forceful diesel pumps. All of this waste of funds and environmental damage occurred because the obvious solution of restoration has not been accomplished.

7.0.0 References & Studies

1940, "Geology of the White Lake Basin" by Cairns includes the Twin Lake Area. The White Lake Basin is just over Parker Mt. from Twin Lake.

1941, the Bostock Geological Government Service of Canada included Twin Lake information.

1967, Dr. Neil Church presented "Geology of the White Lake Area" to UBC.

1973 BC Lands & Forests Twin Lake Botham Report provided historical and scientific water information on the Twin Lakes Area and recommended a high and low surface water level which limited the ranch surface water withdrawal. The gravitation overflow gate controlled pipe from Lower Twin Lake to DL 280 is also described on p. 7-9.

1981, **Dr. G. van der Kamp**, a well known hydro geologist wrote a letter stating that the annual estimated aquifer recharge was limited to about 400 US g pm and "It appears that water consumption in the Twin lakes watershed may already be near the maximum sustainable yield".

1994 the EBA Twin Lakes Golf Course Hydrological Study stated the annual estimated recharge of the aquifer to be 756 US g pm. This study was completed on behalf of the Twin Lakes golf course to support the many layers of development applications. Hydro geologist, Richard Guiton of EBA at an RDOS open house meeting in January 1996, stated "from the data and the subsequent, recommendations development was not favorable. There was not enough water available in the basin, and it was not good for the people or the environment".

2007 & 2010 EBA completed two update letters supporting the 1994 Study assuming there had been no new housing in the area when, in fact ,there had been approximately 30 more residences built.
2008, the "Geology Penticton Tertiary Outlier" by Dr. Neil Church included Twin Lake info.

2010 the Summit Aquifer Capacity Study concluded that the annual estimated recharge was about 570 US g pm **and "additional water demand from the development may not be achievable in the long term"** (Summit Executive Summary p. iii)

2011 the Golder Peer Review agreed with the Summit study.

2015 RDOS Area D Infrastructure Study - includes an aquifer update by Remi Allard

2016 the TLGR Golder Hydrogeological Twin Lake Area Study denied any surface water irrigation licenses in the Twin Lake Area and used a higher water recharge than Summit.

2019 BC Feasibility Flood Study – Park Rill & Twin Lake. See the RDOS website.

2019 the Terms of Reference for the 2nd Phase of the TLGR Development by Golder with 3 references all to Golder's past work and the 2012 **Water Use Plan** of the TLGR Developer's Waste Water Treatment Designer, Michael Seymour, A.ScT.

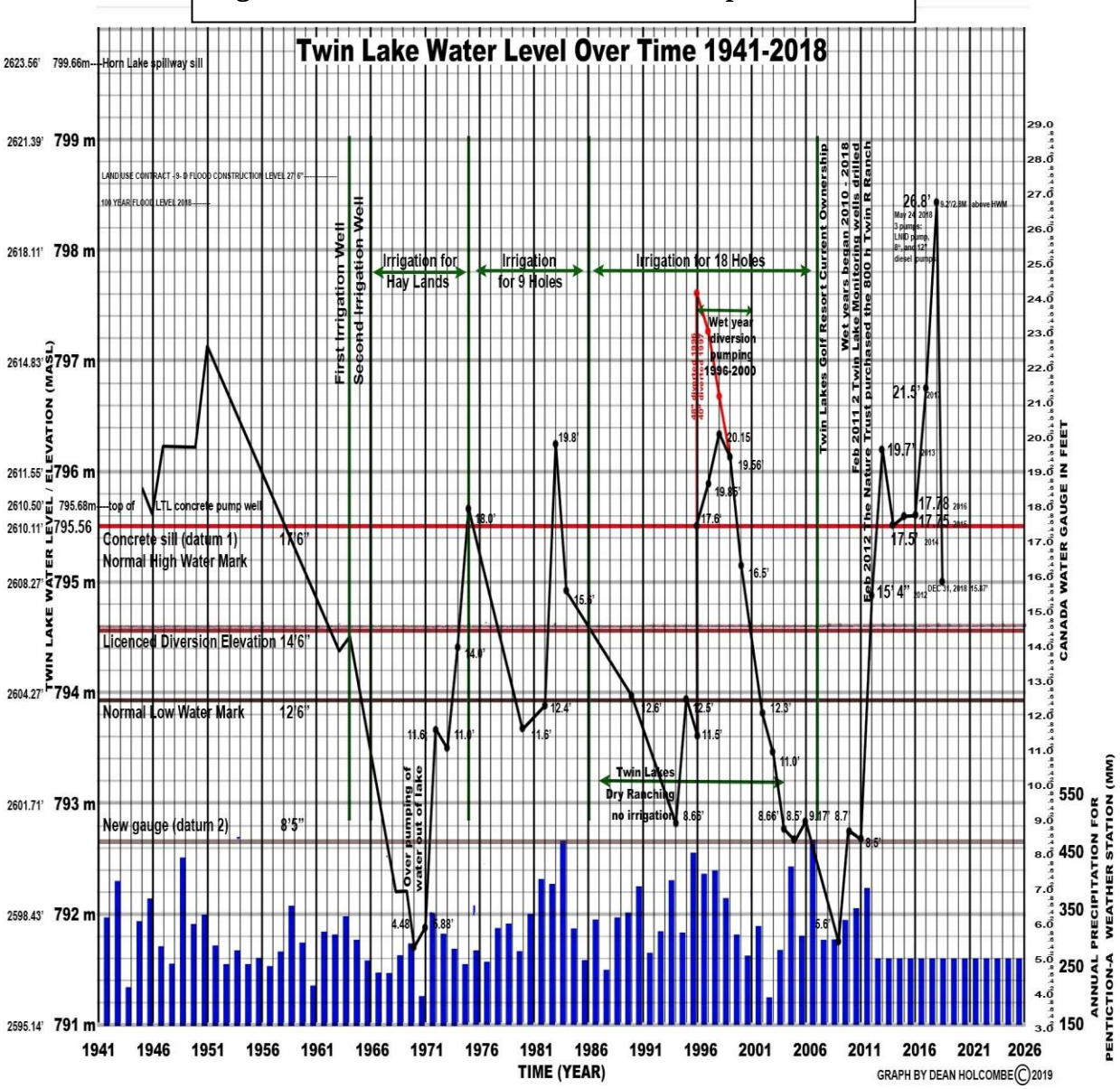
2021 August RDOS Ecora Lower Nipit Improvement District Engineering Assessment & Acquisition Plan was completed. In Jan. 2022 the RDOS refused the conversion of LNID to an RDOS Service Area stating the Park Rill Waterway improvements should be from the lower elevation to the higher elevations. This Report has important information for the LNID stating that the overflow gate controlled culvert & pipe is the recommendation over pumping. Ecora recommended a 5.9 ft. overflow culvert, 967 ft. long estimating the cost to be $1,598,000 and with a 66% grant would raise the annual LNID fee to $515 from $300.00. This study did not consider directional drilling or wetland restoration.

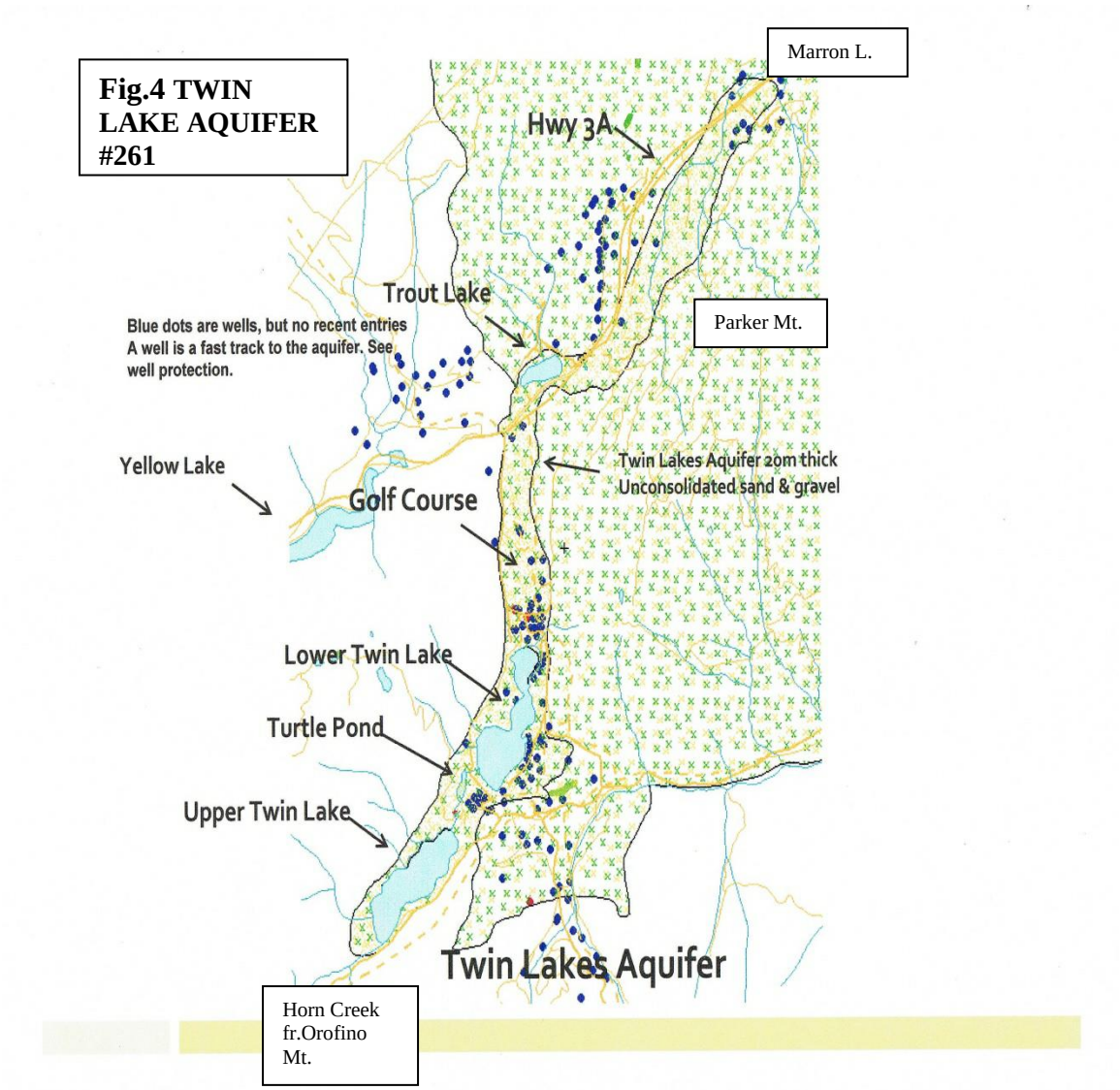
8.0.0 FIGURES

FIG. 2 PRE-1930 TWIN LAKE AREA MAP

Fig. 2
Pre-1930 Twin Lake Area Map, courtesy of UBC Archives Library, July 2018.
The broken lines show ephemeral creeks - creeks that run in the spring of wet years or when there is increased snow pack.
Note; Lower Horn Creek flowed from LTL with an overflow outlet.

Fig. 3 Lower Twin Lake Water Level Graph over Time





Twin Lake Sand & Gravel (Alluvial) Aquifer #261 with wells entered before 2008

Fig. 5 Surface Watercourse of Twin Lake 1975

9.0.0 APPENDICES

9.1.0 LOWER TWIN LAKE WATER LEVELS FROM LNID RECORDS, 1970 -JULY 2022

Lower Twin Lake (LTL) water level readings are in vertical feet, according to the hydrometric station set in 1968. The Upper Twin Lake (UTL) and Turtle Pond (TP) readings for water storage were in both feet and meters. Each of these three water bodies has a Water Canada Gauge (WCG). The TP had a new WCG in 2012, but was reset in 2013 as fencing had been done. The UTL 1991 storage record was in feet, but was reset in metres in 2013.

1970 **October 1 -** LTL was at **4.48 ft**
(there was irrigation ++ see old letters written Nov 2, 1970 from the District Engineer, ED Anthony of the Water Rights Branch to R.A. Wassman and Wildwood Gabriola Estates Ltd – leaser and owners respectively of Upper Twin Lake Ranch DL 427. Wassman was the owner of the Middle Twin Lake Ranch (SE portion of DL 280) and the present Twin Lake Golf Course lands. The letter states that "the continued pumping of the lake will eventually destroy the lake for any useful purpose". Wassman had begun to develop a 9-hole golf course, but his death in 1971, "untimely death" slowed the Golf Course construction.

1971 **October 1 –** LTL was at **5.88 ft**
The Upper Twin Lake Ranch, DL427, the Twin Lake's Guest Ranch at the north end of the LTL plus the pasture land at the present day golf course were ordered not to irrigated in this year. This was a year of above average precipitation. LNID members stated there was a large freshet but the lake was very low in the spring and irrigation water was still being pumped by the Middle Ranch of DL 280. It was assumed that much of the freshet went to fill a depleted aquifer. Wildwood Gabriola Estates purchased the Greens Upper Twin Lake Ranch (what is now the Nature Trust of BC) and applied to build 4000 residences with swimming pools and riding rings.

1972 **May 23** – LTL was at **11.6 ft**
Lower Horn Creek was flowing into Myers Creek. Freshet was about 10 ft or 1,038 acre ft.
May 13 to 20
LTL rose 2.92 ft., with an average inflow of 30 acre ft/day. Horn Creek peak flow was 30 cubic ft./sec.

1973 (month unknown) **-** LTL was at **11 ft**

1974 **March 21** – LTL was at **14 ft.**
A 9-hole golf course opened. **October -** LTL was at **12 ft**.

1975 LTL was up 6 feet to **18 ft**. Some irrigation occurred at the 9 Hole Twin Lakes Golf Course & by Wildwood Gabriola Estates of the Middle & Upper Twin Lake Ranches.

1976 to 1981 in the Hadley Water Graph. 1979 Wildwood Gabriola Estates cancelled their development applications which had been reduced to 200 residences and sold to Kriegers.

1980 LTL level was **11.6 ft**

1981 An application was made for a TLGC strata housing development along Range Rd.
May 20- a letter of refusal for a water licence on Horn Creek to Si Siebens (File no. 0368037) was written by Deputy Controller of Water Rights as "there is insufficient water in the source". This source, Bear/

Horn Creek, is the source of the spring freshet water to UTL and which provides the annual water in the creek/lake systems & the aquifer.

1982 WCG was dislodged.

1983 LTL rose from **12.4 ft**. to **19.8 ft.**
Jul. 4 LTL was **19.45 ft**. There was above normal snow pack and heavy rain with some ranch & TLGC irrigation**.**

1984 LTL was at **15.6 ft**. and all storage full (culvert at the dam was closed).

1985 No record (?)
1986 There was minimal spring run–off. LTL dropped but no measure due to dislodged WCG. The18 Hole Golf Course opened. An anecdotal observation by a Willowbrook farmer was that the TLGC irrigation seemed to affect his Willowbrook well level. Mr. Krieger of Twin R. & White Lake Ranches became a member of the LNID as he was concerned about the TLGC irrigation. Krieger's storage at the earthen dam was 4 ft. (the slide culvert was kept closed to gain1 more ft of water storage. Mr. Krieger suggested the TLGC pumping was affecting the decreasing LTL level. Ranch irrigation stopped due to a pending sale.

1987 No run-off but Turtle Pond had water.

1988 No run-off but Turtle Pond still had water.

1989 Jul LTL decreased but had **7 in. of seepage** (there was no surface water flow from Turtle Pond through the Eastview Rd. culvert to LTL). There was a good snow pack but **most water was absorbed as ground water before reaching the LTL.**

1990 LTL was **considerably less than 12.6 ft**., and rose by only **1.1ft**. or **13.75 in**. (6 inches from direct precipitation +7.75in. run off from Turtle Pond) - decreased snow pack for a few years. Upper & Middle Twin Lake Ranches were purchased by Jim McPherson and were together called Twin R Ranch. Mr. McPherson locked the slide culvert shut so that no water flowed to the LTL. The LNID opened the culvert which allowed16 inches of water to be released from the UTL slide culvert during first 2 weeks of July & Turtle Pond rose 3.5 vertical inches toward the Eastview Rd. culvert and **12.5 inches** ran from Turtle Pond to LTL but **LTL rose only .75 in.**
After the culvert was opened by LNID, Mr. McPherson refused to co-operate with any waterway management until his sale in 2011.

1991 LTL was at **13.75 ft. with 4 ft. of stored water held at the 4 ft**. spillway by Mr. McPherson. The concrete spillway had logs placed on top to increase storage by 2 ft. to 6 ft.- by whom? The LNID's Bob Tate and Hugh Goldie Water Report was completed and on page 8 it states that "daily domestic water licences on LTL measured 12,000 to 14,000 gallons per day and irrigation licences exceeded 250,000 gallons per day. This did not include all the ground water used in the Twin Lakes Valley – there were now many private wells and with 5 golf course wells, water consumption was high".

The LNID realized that water levels of LTL required knowledge of all lake levels, storage, irrigation, diversions and ground water-use. The condition of the UTL outlet/ channel to the dam, the slide culvert status and the amount of water being stored at the earthen dam/ Turtle Pond are all important factors. Besides the lake levels, snow pack, ice-on and off, temperatures and rain fall should all be considered in order to predict the next year water in-flow capacity. **This waterway requires cooperation & understanding by all land owners drawing water from this hydrologic system**.

1992 No recordings.

1993 By **Jul 20** there was **3ft** of freshet water into LTL with UTL full and **slide culvert** was again **locked** in closed position. There had been no irrigation of the DL 280 pasture from LTL since 1987 and none after the 1990 purchase by J. McPherson. The previous owners, the Kriegers, irrigated about 2 ft. of water from LTL when LTL was above the required 12.6 ft. level (as per Botham Report).

1994 **May LTL** was at **8.75 ft.** on WCG. The snow pack/ run off was decreased.
1995 **May LTL** was at a normal low water level of **12.5 ft.** but up 2.5 ft. Twin R Ranch's irrigation sump pump house on DL 280 was removed. Approximately 2 ft. of water was used over the summer for evaporation, seepage and domestic use.
Dec. 8 Ice-on.

1996 **Apr 10** was ice-off.
May LTL rose 33 inches to **11.5 ft** and continued to rise to a peak **17.6 ft.** 6 to 7 ft. was diverted at the Horn Creek and South White Lake Rd. crossing on DL 4169s where water ran all winter into Si Siebens field (diverted 50% of the Horn Creek flow). DL 4169s had a natural land hollow to act as a reservoir. The LNID planned to install a temporary N. pump in the spring of 1997 with the old 1500 ft diversion pipe, but they were unable to relocate the pipe. The Dept. of Hwy. had installed this concrete diversion pipe along Lower Horn Creek and it was used from 1952 to 1962 from LTL to a natural earth reservoir on DL 280. The LTL overflow outlet was closed in 1961/62 due to low lake levels by Mr. Wassman (1973 Botham Report).
Nov 24 was ice-on with LTL at 17.5 ft. & UTL at 4 ft..

1997 In **Mar** LNID installed a low pressure high volume submersible mining pump to divert water to the Parc/ DL 280. LNID was instructed by Ministry of Environment (MoE) to begin pumping water out of LTL (2 cubic ft/sec or 800 gal/min. or 1/3 inches from LTL/day). The vertical 1/3 in. depends on how large the lake is at the time.
Apr 16 was ice-off.
May 1st LTL was at **17.65 ft**. and water ran over the spillway of UTL at 4.6 ft..
May 8 LTL was at **18.35 ft**.
May 15 LTL was at **19.25** ft. (diversion ditch dug to Si Siebens DL 4169s natural land hollow to receive ½ freshet flow from Horn Creek above Horn Lake).
May 22 LTL was at **19.65 ft**. - LTL rose by 3 inches /day even with pumping & diversion. Pumping continued to Oct 30/97.
Jun 5 LTL was at **19.85 ft.** (2.5 ft over normal high water mark and Si Siebens excavated large ditch through his property and the run- off water created 2 lakes covering over 20 acres on Sieben's property.
Aug 1 LTL was at **19.5 ft**.
Aug 30 LTL was at **18.25 ft**. (LTL level had been successfully reduced by 7 to 8 ft.) with pumping to DL 280 and diversion to south White Lake Rd. Valley (Si Siebens DL 1469s).
Nov 1 -unable to find the old ranch, concrete diversion pipe, LNID completed a Right of Way agreement in principle on a hand shake & initials with McPherson and Denton Black of 325 Westview Rd. LNID installed their permanent pump & 6 in. diversion pipe works beginning Nov.19 & completed Nov. 23. LTL was pumped to **16.5 ft** in order to install the works. J. McPherson would not sign a legal agreement. The LNID survey, pump & drainage pipe into DL 280 field cost $40,000.00 paid for by LNID members. In 1997 Siebens property DL 1469s hollows received about 48 vertical in. of water.
Dec 13 was ice-on.

1998 **Mar 25** was ice-off.
Mar 28 - LTL was at **16.33 ft**.
May 16 LTL at **19.5 ft**. – run-off into LTL was 31 in./ 2.6ft. Greatest flow rate Apr. 25 to May 9.

May 18 the LNID diversion pump began pumping to DL 280/Park Rill. LTL @19 ft. UTL @ 3 ft.
Jun 8 LTL peaked at **20.15 ft**.- electrical inspector stated must get permit for permanent pump (pump stopped Sept 14). Rain ++ late Jun. to mid Jul. No water drop until mid Jul.
Si Siebens was no longer able to take Horn Creek water due to his development and closed the diversion ditch & the 8 in. culvert. Electric storm damaged the pump & seals were leaking.
Dec 24 was ice-on.
.
1999 **Apr 8** was ice-off.
May 5 LTL was at **18.5 ft**. and dam spillway at the slide culvert/storage of UTL at **1 ft**.
May 8 Pump on LTL 18,5 ft. & UTL at 2.5 ft.
May 25 LTL at **19.38 ft** and spillway at the slide culvert at the dam at 5 ft. & 1 ft. over spillway.
May 31 LTL at **19.56 ft**. and spillway at slide culvert at the dam at **7.5 ft**. Slide culvert was opened as UTL capacity was too great. Pumping began.
Sept 14 LTL was at **17 ft.** and spillway at culvert at dam at **5.0 ft**. - diversion pump shut down.
In **1997, 1998, 1999** each year the total diversion-pump released 10 ft from LTL plus in 1997 & 1998 4.6 ft. was diverted from Horn Creek above UTL to a hollow on Si Siebens' property DL 1469s.
Dec 20 was ice-on.

2000 **Mar. 25** LTL was at **16.45 ft**. and spillway storage at culvert /dam works at 2.3ft.
Apr 1 was ice-off. Snowpack low.
April 30 LTL was at **16.35 ft**. and WCG spillway at slide culvert of dam at **2.1 ft.** Low snow pack.
May 13 LTL was at **16 ft 6 in. Peak 16.5 ft.**
Jul. 15 LTL was at **15.6 ft.**
Oct 15 LTL was at **15.0 ft.**
In 2000 there was minimal freshet water into LTL with no diversion pumping and the pump pulled for maintenance then stored until 2013. Wet years began again in 2010, but the lakes were at a very low level so that no pumping was required.
Dec 8 was ice-on.

2001 - low snow pack- no record, but only 2 feet of water with spring run- off (average is 4 to 7 ft.).
Apr 8 was ice- off.
Dec 9 was ice-on.

2002 **Apr 13** was ice-off
May LTL was at **12 ft 3 in**. (5 ft. below high water level). **UTL dam** slide culvert WCG was at **.56 ft**. Average run-off usually received by mid July depending on snowpack, timing of melt & spring precipitation. No water into UTL.
Dec 17 was ice-on.

2003 **Mar 29** was ice-off.
Apr 23 LTL was at **11 ft** - slide culvert closed. Dam culvert was at .2 ft. from bottom of slide culvert and Turtle Pond 4 horizontal ft. away from Eastview Road culvert. Snow pack was normal.
May 5 Slide culvert opened. UTL at 2.4 ft.
May 8 Turtle Pond filling and nearly full but no surface water spill into LTL. UTL at 2.17 ft & .LTL was decreasing
May 15 Water into LTL 2 in. & UTL at .6 ft..
Nov 30 Ice-on.

2004 **Mar 30** was ice-off.
Mar. 30 was ice-off. The run-off began and ice- off the lake 2 weeks earlier than average.
May 5 LTL was at **8 ft 9 in**. with decreased snow pack & there was no snow left in the water shed (earliest total melt ever observed). Slide culvert was locked closed and water was at 1 ft from bottom of the slide culvert but there was no water in the channel from UTL outlet to Turtle Pond.
Apr. 15 - 3.5 ft at the slide culvert dam and ~3.5 cu ft of Horn Creek flow at the culvert on Horn Creek at DL 41695 (White Lake Road S. culvert) but the creek bed dried ½ way to UTL within a week. Some water spilled from the old west diversion pipe of DL 427 (old pipe diversion for water licence #10471 in 1930) did reach UTL but only for 1 week. LTL was at the lowest level in 10 years, but still had some water in the Turtle Pond.
Dec 10 was ice-on.

2005 **Apr 4** Ice-off.
Jul 9 LTL peaked at **8.5 ft**. but down 3 in. since 2004 (decreased snow pack but increased rain in June). UTL outlet was filled/collapsed/trampled by cattle and UTL water level was high. Logging stopped in the Horn Creek Watershed due to alternate area logging to remove pine beetle forests.
Dec 9 Ice-on.

2006 **Apr 6** Ice-off.
May LTL peaked at **9.1 ft**. - up 7 inches since 2005. 2006 was the last time water ran under the Eastview Rd. culvert for 3 years. Turtle Pond filled but overflowed only minimally to LTL - 7 inches.
Dec 29 Ice-on.

See Bob Wilson's lake levels – not able to relate to the normal high water level (NHL) of 17.6 ft. as we had lost the water gauges and were unsure of the sill referred to in the Botham Report.

2007 **Apr 5** was ice-off.
Water in Turtle Pond rose to the Eastview Road culvert but did not cross the road. Only ground water seepage moved into LTL. Golf Course sale was pending and irrigation increased. Logging company reforested the clear cuts. Horn Creek forestry roads are adjacent to the steep creek bed and many culverts were no longer cleared of debris so caused large washouts.
Jun. LTL at 10.6 ft.
Jul. 2 LTL **peaked at 15 ft**.(was culvert open?)
Oct. 4 LTL **10 ft**. (loss of 5 ft. since peak & about another 4 ft. before ice-on in Dec.)
Nov 30 was ice-on.

2008 **Apr 10** at ice- off. LTL was only **6 ft**. Water began to run out of UTL towards the dam but then the UTL outlet was filled by the renter on Twin R Ranch and water stopped. **Turtle Pond – a wetland** important to replenish ground water began to **dry**.
Ju. 8.58 ft. LTL peak.
Dec.15 at ice- on LTL was at 6 ft. The TP was very low.
Twin Lake Golf Course sold and there was increased constant irrigation throughout 2008.

2009 **Apr 16** was ice-off**.** LTL was at 6ft.
Jun. LTL at 6.91 ft.
Jul 20 LTL peaked at **8.5 ft**. Snow pack was below normal.
Nov 18 LTL WCG was at 6 ft.
In 2009 no water ran to UTL or in Horn Creek once out of the mountain at DL 1469s, but water did run at higher elevations in the watershed. Horn Creek water was observed from the diversion pipe in DL 427 from Horn Creek culvert to UTL and spills over the pasture. In dry years the water has been observed disappearing into the ground (assumed to recharge the aquifer). But even in dry years there is some

diversion water from Horn Creek to the west side of the pasture above UTL – see the diversion water licence from 1930. The Turtle Pond had a hard grass covered bottom with no water. Speaking with Dude Ranch visitors in the early 1960's no one had ever observed a dry Turtle Pond.
Dec 3 was ice-on. LTL was at **5.6 ft**. **

2010 **Mar 17** Low Snow pack with ice off LTL at shallow north end. Mar.21 ice off deeper south end & **Mar 28** was ice off UTL. UTL dam WCG was at .6 ft.
Apr 16 LTL WCG was at 6 ft
Apr 17 Water began to run at Si Siebens south White Lake Rd. in DL 1469s culvert for about 40 ft following 3 days of 20 degrees C and then rain. Large washouts occurred at km. 4 of the Longhorn Creek Forestry Rd.
Apr 20 Water reached UTL**.**
May final Twin Lake **Aquifer Capacity Study ($22,000)** released. Study paid for by LNID, with a grant from Ministry Municipal Affairs &Housing (MoMA&H) with shortfall by OBWB.
May 5 LTL at 5.92 ft. Some water reached the old fence in Turtle Pond (was dry for all of 2009 until May 2010).
May 9 the Turtle Pond Floor was covered with water.
May 11 UTL was at 1.5ft on the WCG with dam at .2 ft. (the UTL outlet has a channel for water to flow to the earthen dam) and beyond to the TP.
May 15 The Turtle Pond was filling and water was 4 horizontal ft. from the culvert on Eastview Rd.
May 28 Water in UTL was at 1.8 ft on the WCG.
Jun 2 Water crossed under Eastview Rd. from Turtle Pond, but only in rocked in channel, not yet reaching LTL. UTL filled to 2.6 ft on the WCG, and at the dam at 1.4 ft. showing water moving through.
Jun 4 Water reached LTL in 2 days and ran **until July 13** which **gave LTL 3 ft. of freshet**.
Jul. 14 LTL was at **8.7 ft**. This was a very unusual spring with a lot of rain and increased snow in the watershed in the spring. The Testalinden mud slide S.W. of Oliver occurred & this changed all earthen dam BC Province protocols. There was twice the normal rain and cool weather. Above average precipitation was recorded through all of June, Sept, & October. The Twin Lake Golf Course irrigated less, but creating dry hard, sandy patches of grass.
Aug 8/10 - LTL WCG peaked at **8.9 ft.**
Oct 30 LTL lost only 4 inches of water by rather than the average 3 ft. loss in UTL & LTL (2 ft/yr. loss over the past 3 years with continuous golf course irrigation). No surface water entered LTL in the past 3 years**. No water was stored as** the slide culvert remained open.
Dec 31 was ice on. LTL WCG was **8.1 ft.**

2011 **Feb** - BC Ground Water Observation Wells #403 & 404 were installed at either end of LTL.
The Nature Trust purchased the 800 h Twin R. Ranch, now known as the Twin Lake Ranch.
Apr 10 was ice- out of culverts at south White Lake Rd. in DL 1469s.
Apr 11 was ice-off LTL.
Apr 14 LTL WCG **was** at **8.5 ft.**
Apr 16 A small flow of water was observed into UTL from DL 427 diversion pipe.
May 6 Horn Creek water reached UTL. LTL at 8.75 ft. More washouts occurred on Longhorn Forestry Rd. at km2.
May 18 Some water moved into LTL and storage of UTL was at 3ft. Horn Creek stopped with LTL at 10.83 ft.
May 22 Water flowed over the dam spillway. LTL at 8.75 ft.
Jun 16 LTL was at **12.5 ft**. and some spillway water flowed into Turtle Pond & culvert opened.
Aug 4 LTL peaked at **15.8 ft**.
Aug 10 No water into LTL, but water still out of UTL into Turtle Pond.
Nov 15 LTL at 13.6 ft. with "freshet was ~5 ft on the WCG" with culvert open
Dec 10 was ice- on.

2012 **Apr 15** was ice- off and LTL was at **13.6 ft.**
Apr. 23 UTL dam culvert closed today.
Apr. 28 Water passed through South White Lake Rd. culvert 2 inches deep towards UTL.
Jun. 6 Freshet finished no water flow into UTL from Horn Creek.
Jul 5 Flow of water into LTL stopped.
Jul 6 LTL peaked at **15.75 ft**. to gain about 2 ft. – vertical gain is less as the lake spreads out.
Nov 29 LTL WCG was **14.25 ft**. & **UTL at 0**. LTL evaporation, use & seepage was about 18 in.
Dec 16 was ice- on.
2012 the Ministry of Forests Lands & Natural Resources Operations & Rural Development (FLNRORD) suggested that LNID monitor the Twin Lake water levels in relation to trigger points and dates. Thus a new form of lake monitoring began.

2013 Snow pack was average. Power for pump reconnected. Pump replaced into lake. Dam culvert was open all winter.
Apr 4 Ice-off & LTL WCG **13 ft. 11 in**.
Apr 6 Heavy rain & water ran thru Eastview Rd. culvert about 2 in. deep.
Apr 29 LTL at **15.6 ft**.
May 13 Culvert remained closed but water over spillway until Aug 25.
May 14 LTL WCG **17.67ft.**
May 14 Power reconnected to pump (not used since 1999). Rain ++ all spring.
May 16 10mm of rain.
May 19 LTL WCG **17.84 ft**. & .5ft. of water was flowing over the spillway at the dam. The culvert was down.
Jun 16 LTL at **19 ft**. and pump pulled for maintenance. Strata Rd. was soft.
Jun 19 Minimal water into UTL from Horn Creek, with 2 in. depth of water moved over the dam spillway.
Jul 1 Water over N. strata road. LTL was at **19.6 ft**. and still some water into UTL with 2 in. over dam spillway and .5ft. in Eastview Rd. culvert and water into LTL.
Jul 11 LTL peaked with WCG at **19.7 ft**. UTL at **3.88 ft. storage** (+1 ft at bottom of WCG).
Jul 30 LTL down to **19.5 ft**. with culvert closed. No water over spillway. One inch of water was in Eastview Rd. culvert moved into LTL.
Aug 19 Replaced burned breather pipe of diversion pipe water line.
Aug 25 LTL WCG at **18.45 ft**. with UTL storage at 4 ft. Began LNID pump with sequence LTL 12 hr. on and12 hr. off. One inch depth of water flowed into Turtle Pond and 3 inches flow into LTL. Pump moved about .5in. of water per day.
Sept 3 to Sept.16 dam culvert was opened to release 1 ft. of water. LTL at **18.3 ft**. & UTL storage was at **3.75 ft**. with heavy rain of 12 mm and Sept 5 another 12 mm of rain.
Sept. 16 culvert closed and LTL at **19.1 ft**. and storage at **UTL 2.7 ft**., dam at 2.1ft., Eastview Rd culvert 6 in. deep into LTL.&10 mm of rain.
Sept. 23 pump began 24 hr./day. LTL at **18.9 ft**., **UTL at 2.7 ft.** and **dam at 2.1 ft** with 2 in. of water through Eastview Rd. culvert.
Oct. 7 - Pumping only ¼ to ½ inch/day with 4 mm rain.
Oct. 10 to 22nd - Culvert opened to release another ft. of water from storage.
Oct. 10 LTL at **18.4 ft**. UTL at **1.9 ft of stored** water and water still running into UTL from Upper Horn Creek.Dam at 1.7 ft. and 1 in. of water moving through Eastview Rd. culvert.
Oct. 17 Turtle Pond very full and over the WCG with only 8 in. to the top of a 4 ft. fence post (above water). **LTL was 18.6 ft., UTL 1.2 ft. & dam 1.7 ft.** and1inch thru Eastview Rd. culvert.
Oct. 22 LTL at **18.45 ft**., UTL at **.9 m**. (holding 2+ ft. of water) dam at **1.28 ft**. and 6 in. deep water thru Eastview Rd. culvert. Only 6 in. of TP post showing. Temp was 2C and foggy.

Nov 1 LTL at **18.5, UTL at1 ft. of stored water, dam at 1.2 ft. of stored** water and 1 in. of water in Eastview Rd. culvert.
Nov 16 to 28 The pump was rattling & only pumping ¼ in./day, but both Lakes full/larger than normal (N).
Dec. 5 Pump off as lake ice- on. **LTL at 18 ft**. UTL at **1 ft**. of storage and dam at 1.2 ft. of storage with 1 in. of water sitting in Eastview Rd. culvert. TP full and will spill at spring thaw.

2014 **Apr 7** Ice- off with LTL WCG at **17.5 ft**. Dam at **1.6 ft**. UTL WCG dislodged and reset.
Apr 17 No water running but flowing at higher elevations above the upper culverts at S. White Lake Rd. - water could be heard running under the ice. No water in the Eastview Rd. culvert (sitting at the lip).
Dam slide culvert was closed. Dam & UTL were each holding about **2 ft.** of water. The UTL WCG was set 18 inches from the lake bottom and the pole is18 inches above the WCG.
Apr 16 & 17 gentle rain of 10 mm. UTL WCG had fallen to **1.58 ft.**
Apr 22 Horn Creek water into UTL.
Apr 24 LTL at **17.6 ft.**
May 21 Pump was on until May 29 & ordered off & on again July 6.
Jun 3 Water in Horn Creek stopped flow to UTL. The water was over the WCG in UTL & at dam.
Jun 13 Culvert opened to release 1 ft. of water from UTL.
Jul 6 Pump began & removed ¼ in. of water in 24 hr.
Jul 18 LTL peaked at **17.5 ft**. Good flow into LTL but little gain. Golf Course irrigation ++ and tanker truck filled from LTL (for White Lake Rd. fire suppression & domestic water for Grand Oro Rd.?).
Aug 7 No water flow into LTL, dam at **1.8 ft. of storage**.TP at **.4m.** on WCG (at .4m+ on new WCG, water will begin to flow through Eastview Rd. culvert).
Sept 1 Culvert closed with **1.65 ft. of storage at dam**, outflow channel from UTL was14 in. deep and LTL at **16.84 ft**. No pumping but water running in Lower Horn Creek of DL 280.
Sept 23 Dam culvert opened for 2 weeks.
Dec 1 was ice- on with LTL at **15 ft.** The WCG was dislodged but dam structure WCG remains.

2015 **Mar 14** was ice- off**. This was a year of non compliance and blocking of the LNID's SRW** which began on March 15 by a new owner at 325 Westview Rd. The pump and SRW is situated across the North East LTL at 325 Westview Rd. & the field of DL 280. This SRW was surveyed 1.5 years previous to the March 15 purchase and was registered in the Land Titles office. Reaching the pump by water or land was almost impossible. No pumping occurred in 2014 as LNID was unable to even check the pump due to the new owner blocking the SRW. Power from the transformer was damaged twice and required a Fortis repair.
Mar 21 Ice- out of culverts at South White Lake Rd. **LTL at 15.67 ft.** UTL/ dam storage was **1.4 ft. & TP .1m** of storage.
Mar 26 Water into UTL with lake level as on Mar. 21.
Apr 8 Water moved over dam spillway.
Apr 11 Water ran into LTL.
Jun 8 Horn Creek stopped the flow to UTL. LTL peaked at **17.75 ft**. with UTL **storing 4.95 ft** & Turtle Pond **.8 m of storage**.
Jun 15 Flow over spillway stoped.
Aug 6 email from MoFLNRO, R. Warner re: drought level 4 directive. Aquifers & creeks were warm & fish were affected and thus requested to release all stored water.
Sept 3 No water to LTL from Eastview Rd. culvert.
Nov 6 The culvert was opened as/ BC order and then was shut Feb 28/16.
Dec 19 was ice-on with LTL at **16.5 ft.** UTL storing **1.4 ft**. & TP storing **.5 m**.

2016 **Mar 24** was ice-off**.** LTL was at **16.65 ft.** with UTL storing **1.5 ft**. &TP at **.4m.**
Apr 7 Water entered into UTL

Apr 18 Water flowed over spillway.UTL was **storing 4.95 ft.**
Apr 19 Water moved into LTL.
May 15 Horn Creek flow stopped to UTL. **LTL** was at **17.75 ft**. UTL was storing **4.95 ft**. with **TP .6m**.
May 24 LTL peaks at **17.8 ft**., UTL **storing 4.9 ft., & TP storing .65 m**.
Jul 25 No water crossing dam spillway. **LTL** was at **17.16 ft**., **UTL** at **4.9 ft.** & **TP** at **.6m.**
Oct 4 - flow to LTL stops with **LTL at 17.4 ft**., UTL **storage was 2 ft., & TP storing .6m.**
Pumped about 1.9 vertical ft. Freshet estimated at 5ft.
Dec 11 Ice- on LTL at **16.5 ft., with UTL storing 2 ft. & TP storing .6m.**

2017 A season of flooding. Snow Pack 150% of normal.18 inches added to storage for UTL with sand bags on the concrete spillway. Debris was down+ in the field above UTL from Orofino Mt. washouts.
Apr 17 was ice- off. LTL **16.6 ft**., UTL **2.1 ft.** of storage and TP **.18m**.of storage.
Apr 20 Horn Creek water to UTL.
May 1 Water over dam spillway. LTL **16.75 ft., UTL 4.9 ft. of storage, TP .4m.** of storage.
May 2 Water into LTL **16.8 ft**., UTL at **4.9 ft**. of storage, TP .**45m**.of storage.
May 20 LTL peaked at **21.53 ft**., with UTL **5.1 ft**. of storage, & **TP 4.2 m**. of storage.
Jul 2 Horn Creek stops with LTL at **20.15 ft**., with storage in UTL of **6.5 ft**. & TP **1.2 m**.
Jul 10 Spillway with 18 in. of sand bags stops spilling. LTL at **21.17 ft**., & storage in UTL **6.5 ft.** & TP **1m**. with Eastview Rd. 3 ft. culvert grate covered. The lakes are one. No water able to flow.
Aug 12 Culvert ½ open & **shut Oct. 2.** All UTL storage water must flow through LTL to decrease lake levels before the next year freshet so that there is some capacity to accept the spring run-off.
Oct 14 Water to LTL stopped, thus most (see Dec. 14) stored water released. LTL at **17.1 ft**.
Dec 14 was ice- on with LTL at **16.75 ft**., storage in UTL at **1.9 ft**. & TP at **.79 m**.
2 pumps on – Emergency Measure (EM) diesel Jun 8 to Sept 17 and LNID electric pump on May 9 to Nov.15. **Total pumped** was **about 5 vertical ft. of water**. **Freshet was about 13 vertical ft.**

2018 Second year of flooding, sand bagged properties with a wall of sandbags 8 ft. above the full lake supply of 19.6 ft. OK Valley snow pack was 206% of normal. A 300 m long 10 ft. high wall was built at the N. TL strata to avoid lake contamination by a pump up sewage system. About 33 residences had water damage. Residents began bagging by early April. Fire Service employees came to assist full time residents.
Apr 13 Horn Creek was raging with debris & large washouts above and at the White Lake Rd. S. culverts as 2 in. deep water entered into UTL.
Apr 19 Ice-off and LTL at **17.10 ft**., with storage in UTL at **2.6 ft**.& TP at **.4 m**. Flooding in Willowbrook & Sportsman Bowl.
Apr 19 Horn Creek water to UTL with water levels as above. Water reached and filled UTL quickly.
Apr 22 Water over UTL spillway & LTL was at **17.3 ft**., with storage in UTL **39 in**., & TP at **.8m**.
Apr 23 Water flowed to LTL. LTL was at **17.36 ft**. & storage in UTL at **3.93 ft** & TP at **.8m**.
Apr 24 Serious flooding of all downstream properties when the public BCEM meeting was held in Oliver. Horn Creek water just beginning to flow into UTL.
May 1 and water began over north LTL strata road. The driveway was built up 5 ft. with about 280 loads of gravel over 300 m. topped with a10 ft. high Heco bins and sand bag wall.
May 4 A 39 in. culvert was installed by BC Emergency Measures under the supervision of Mike original 48 in. culvert. Water was approaching the top of the earthen dam and the decision was made to release increased water into LTL. The 39 in. culvert filled to release 10 in. of water for about a week.
May 18 Still 6 in. of water in 39 in. culvert but not flowing. 80 Military soldiers arrived for 3 days to complete the 300 m. wall which held back the 88+ acre lake. UTL & LTL was one/level with no water able to flow.
May 23 LTL peaked at **26.78 ft**., with storage of UTL **6.5 ft.** &TP at **.82m**.
May 24 Three pumps began intermittently (often down for repairs) on LTL.

Jun 21 Horn Creek flow to UTL stop. LTL was at **23.93 ft**. with storage of UTL at **5.08 ft**. & TP-**1.8m**.
Jul 16 Water over the spillway with LTL at **21.34 ft**. storage in UTL of **5 ft.** & TP at **2.13m**.
Jul 16 Dam culvert opened and – still open end of Feb 2019 to allow UTL to reach normal level.
Dec 4 No flow to LTL which was at **16.12 ft**. with storage at UTL dam minus1ft., but a trickle flowing & TP at **.46 m**. Water still flowing some from UTL since culvert was open and UTL still in some flood
Pumps on – LNID May19 to Dec.12 and EM pump was on May19 to Nov. 16 with several days off for maintenance/repairs.
Dec 5 was ice- on. LTL was at **16.12 ft.,** UTL was at **-1 ft**. of storage, but water was still running in and through into TP. TP at **.46m** of storage but culvert of Eastview Rd. blocked with ice.
In 2018 14 ft. of water was **pumped** and **freshet** was about **17 ft.** It is said this was a once in 200year flood.

2019 **N**o surface water entered UTL or LTL with snowpack for the Okanagan Valley at **78% of** normal.
April 7 was ice- off with **LTL at 15.9 ft. & storage in UTL .25ft. and TP .35m**.
Nov 30 was ice-on with **LTL at 14 ft.** and no water storage in UTL or TP (both ~ one ft. below normal levels).

2020 Ice off **Apr 15 with** LTL at 14.4 ft. & UTL at .49 ft. Snowpack Feb 10 at 132% N. & Mar 27 at 119% N with fall & spring rain ++
Apr. 18 water into UTL with LTL at 14.4 ft. & UTL at 3.94 ft.
May 5 water into LTL at 14.67 ft. & UTL at .49 ft.
Jun 4 Horn Creek stops. LTL at 17.08 ft. and UTL at 3.11 ft.
Jun 30 dam culvert open 20% cased slow run with less force.
Oct 17 water to LTL stopped with LTL at 17.9 ft. & UTL at .66 ft.
Sept 17 to Dec 17 pump on. LTL at 18.2 ft. to 17.12 ft., UTL was at .82 ft. to .79 ft.
Freshet approximately 7.63 ft. with EUS approximately 4 ft. Pumped about 1.2 ft. (pump slow at 1/8th in./day). **Projected capacity for next freshet about 5.28 vertical ft.**
Dec 17 ice on with LTL at 17.12 ft. UTL at .82 ft.

2021 Ice off Apr 4 with LTL at 16.8 ft. & UTL at 1.2 ft.
Mar snowpack 118% N.
Apr 23 water into UTL with LTL at 16.5 ft. & UTL at 1.4 ft.
Mar 31 to May 6 Pump tested with LTL at 16.36 & UTL at 2 6 ft.
May 15 Horn Creek stops with LTL at 16.4 ft.& UTL at 2.88 ft.
Jun 19 water into LTL with LTL at 16.11 ft. & UTL at 3,24 ft. (not oner spillway this year).
Jun 18 dam culvert opened & shut Oct.27 with LTL at 15.53 ft.7 UTL at .95 ft.
Jun 28 LTL Peak with LTL at 16.22 & UTL at 2.88 ft.
Jul 22 water to LTL stops w LTL at 15,55 ft, & UTL at 2.3 ft,
Freshet about 5.38 ft, with EUS 4 ft. and total pumped .48 ft. (includes 1 inch used for fire fighting).
Projected capacity for next freshet 6.6 ft.
Eastview Rd, culvert was blocked with 18 in. of mud & erosion debris.
Dec.12 ice on with LTL at 15.3 ft. & UTL at 1.3 ft,

2022 Ice off Apr 1
Apr 11 Snowpack 90% of N for S. Okanagan. Early April was just 84% of N.
May 2 Water into UTL with LTL at 14.858ft/4.5m. & UTL at 1.3 ft, /.6m & TP was minus 3 horizontal ft./ -0.9m of storage.
May 30 1 inch of water over the spillway with UTL/dam at 0.99 m. LTL at 14.95 ft/.45m. & TP at .48m.
May 30 small flow of water into LTL. **May 29** Horn Creek stops.

May 30 minimal water over spillway & stops Jun. 22 when culvert opened fully.

July 14 Water into LTL slowing after 5 days of 28 to 30C. LTL at 16.356 ft., Dam area storage is .74 m & TP is .5m.
Sept. 22 **Water to LTL** stopped with LTL at 15.9 ft.
LTL peaked July 13 at 16.37ft. with UTL at 2.4 ft./.74m.
Freshet about 6.47 ft./1.97m.
Projected next capacity 7.69ft./2.3m
Lake ice-on Nov. 30.

9.1.1 Twin Lake Water Levels Chart Legend:

UTL is Upper Twin Lake,
TP is Turtle Pond,
LTL is Lower Twin Lake.
SWLRC is South White Lake Rd. Culverts about 1 km above or South of UTL.
Snowpack is predicted mid Feb. & mid Mar.
EUS is evaporation, use and seepage which historically in 1973 was 3 ft. or 18 in. from each lake. 2017 EUS was 4 ft.
LTL has full lake supply (FLS) at 18.6 ft.
Flood of built infrastructure begins at 19.2 ft. according to tree line & allowed development.
The UTL Water Canada Gauge (WCG) at the dam is set 1 ft. above the bottom – depending on the sand infill.
UTL & LTL are each about 80 acres.
1 inch of water in LTL is about 2.900,074 US g.
LTL vertical normal high water of 17.6 ft. as determined by the 1968 hydrometric station as per the Botham Report.
12.6 ft. was the maximum low LTL water level when water used for the ranch irrigation.
Stor is storage.
MHC is Middle Horn Creek – between UTL outlet & Turtle Pond.
LHC is Lower Horn Creek in the Park of DL 280. namely the overflow LTL outlet.

9.1.2 **Annual Twin Lake Water Level Charts 2011-2022**

Twin Lakes Annual Lake Levels/Watershed & Management Story

Triggers **2011**	Date	UTL Stor ft/m	TP Stor ft/m	LTL water level ft/m		Date **2012**	UTL Stor ft/m	TP Stor ft/m	LTL water level ft/m
Snow pack/precip.	135%N					OK N			
Lake Ice off	Apr 7	-1/.3	na	8.65/2.6		Apr 15	-0	-0	13.5/4.11
South WL Rd. culverts ice out	Apr 10					Apr 14	-0	-0	13.5/4.11
Water into UTL	Apr 16					Apr 24	.6/.18	-0	13.5/4.11
Water over dam spill.	0	May 22	trickle	Fr. HL		0	May24 3/.914	1.64/.5	15.6/4.75
Water to LTL	May 18			9/2.74		Apr29	1/.30	2.29/.7	13.5/4.11
Horn Creek stops	?					Jun6	1/.30	1.64/.5	15.2/4.63
Dam Spill. stop	No flow					No flow			
H20 to LTL stop	Aug 15	na		na		Jul6	1/.30	1.3/.4	15.9/4.84
Dam culvert open	All 2011					Closed May31	1.67/.5		15.4/4.69
Dam Culvert Shut	no					Aug31/Sep 18	MHC dry	0	14.9/4.54
LTL Peak	Aug 5		1.47/.45	14.9/4.52		Aug 5	.33/.1	1.6/.5	16.5/5.02
Ice on	Dec.10	0	0	13.5/4.11		Dec 14	0	-0	13.92/4.24
Pump on	off					off			
Pump off	off					off			
Total freshet	FSS at ice off to FSSpeak. FSS peak – FSS ice off 14.9ft – 8.65ft= 6.25 ft.			6.25/1.9		3.33/1.01			
Total pumped				0					0
Capacity projected	FSS – FSS ice off 23.5ft – 13.5ft =10ft.			10/3.04		9.58/2.91			
Fall EUS				1.4/0.43					2.58/.79
Add info.	Washouts km 3 & 4 FSR. May15 washout SWLRC. Sept 13 no flow from HL & HL at -3ft.					Washout debris in UTL wetland. Jul 21 cattle in wetland. MHC dry Aug 30.Feb 2011 TNT purchased TL Ranch & 2 monitoring wells.			

Twin Lakes Annual Lake Levels/Watershed & Management Story

Triggers	Date **2013**	UTL stor ft/m	TP stor ft/m	LTL ft/m	Date **2014**	UTL stor ft/m	TP stor ft/m	LTL ft/m
Snow pack/precip.	OK N				N – dry snow			
Lake Ice off	Apr 4	1/.3	.59/.18	13.9/4.2	Apr 7	2.5/.76	1.3/.4	17.7/5.39
South WL Rd. culverts ice out	Apr 5				Apr 4			
Water into UTL	Apr 6				Apr22	2.8/.85	1.3/.4	17.5/5.3
Water over dam spillway	Apr 30	4.9/1.5			May11	4.9/1.5	1.6/.5	17.5/5.3
Water to LTL	Apr 6	1.8/.55	1.69/.5	13.9/4.2	May12	4.9/1.5	1.6/.5	17.5/5.3
Horn Creek stops	Aug 5				May31	4.9/1.5 +	1.6/.5	17.5/5.3
Spillway stops	Aug 5				Jun3	**4.08/1.2**	1.5/45	17.25/5.25
H20 to LTL stops					Aug7	2.8/.85	1.3/.4	17.08/5.2
Dam culvert open/shut	Oct 2012 shut Apr24/13			15.25/4.6	Jun12/ Jul8			
						3.4/1.1	2.5/.75	17.25/5.25
Dam culvert open/shut	Sept 13 open			19/5.76	Sept23	2.3/.7		15.7/4.79
	Oct 22 shut			18.45/5.6	/Oct 2	1.6/.49	2.3/.7	16.0/4.88
LTL Peak	July 1	4.9/1.5	1.97/.6	19.6/5.97	Sept 1	2.6/.79	2.3/.7	17.8/5.43
Ice on	Dec 5	2/.61	1.3/.4	18.0/5.49	Dec 1	1.6/.49	.98/.3	15.0/4.6
Pump on	Aug 25				May21	Water entering +pumping		
Pump off	Dec 5	2/.61	1.3/.4	18.0/5.49	May29		1.5/.45	17.4/5.3
Total freshet	Lake peaks – ice off (4.9 +19.6)- (1+13.9) =9.6ft			9.6/2.93	(2.6+17.8) – (2.5+17.7) +.5pumped=. 7 ft. freshet			.7/.2
Total Pumped				3/.91	In May before peak			.5ft/.15m
Capacity projected for next freshet 3.5ft.					FSS (23.5)- ice on (16.6ft) =6.9 ft.			6.9/2.1
Fall EUS	Peaks (24.5ft) – pumped (3ft) -ice on (20ft) = 1.5ft.			1.5/.45	Peaks (20.4ft) – ice on (16.6ft)=3.8			3.8/1.16
Add info.	May12 H20 filling LTL at 3 in/day.May19 H20 over spillway still .5ft deep. Pump & power repairs in spring/summer.				Some water removed for fires before peak. Some H20 running in LHC Sept 1 & no pumping. Cattle fenced out of Twin Lakes.			

Legend: L is Lake, LTL is Lower Twin Lake, UTL is Upper Twin Lake, South WL Rd. is the South White Lake Rd. ~ 1km above or south of UTL and precip. is the amount of annual rain/precipitation.

2.

Twin Lakes Annual Lake Levels/Watershed & Management Story

Triggers	Date **2015**	UTL stor Ft/m	TP stor Ft/m	LTL stor Ft/m	Date **2016**	UTL stor Ft/m	TP stor Ft/m	LTL Ft/m
Snow pack								
Lake Ice off	Mar 14	2.2/.67	.98/.3	15.75/4.8	Mar24	1.5/.46	1.35/.4	16.6/5.06
SWLRC ice out	Mar 21	2.2/.67	.98/.3	15.75/4.8	Apr4	1.5/.46	1.35/.4	16.6/5.06
Water to HL	Mar 26	2.2/.67	.98/.3	15.75/4.8	Apr7	1.5/.46	1.35/.4	16.6/5.06
Water over dam spillway	Apr8	4.95/1.5	1.0/.32	15.75/4.8	Apr18	4.95/1.5	1.35/.4	16.5/5.02
Water to LTL	Apr11	4.95/1.5	1.3/.4	15.75/4.8	Apr19	4.96/1.5	1.6/.5	16.5/5.02
Horn Creek stops	Jun8	4.95/1.5	2.6/.8	17.75/5.4	May15	4.95/1.5	1.97/.6	17.75/5.4
Dam Spillway stops	Jun15	3.0/0.9	1.6/.5	17.67/5.3	Jul25	4.9/1.5	1.97/.6	17.16/5.2
H20 to LTL stops	Sep 3	2.0/.61	1.35/.4	15.67/4.7	Oct4	2.0/.61	2.0/.61	17.4/5.3
Culvert open shut	Nov6	3.3/1.0	1.0/.3	15.75/4.8	Jul26	4.9/1.5	1.97/.61	17.16/5.4
	Feb28	1.5/.46	1.35/.4	16.6/5.06	Aug 9	3.3/1.0	1.8/.55	17.4/5.3
Culvert open shut	Nov 6 Province ordered release all stor. Shut 2016.				Sept12	3.0/0.9	1.6/.50	16.67/5.08
					Sept27	2.0/.61	1.8/.55	17.4/5.30
LTL Peak	Jun8	4.95/1.5	2.6/.8	17.75/5.4	May24	4.9/1.5	2.1/.65	17.8/5.8
Ice on	Dec 19	1.4/.43	1.6/.5	16.5/5.0	Dec11	2/.61 WCG .3	.66/.2	16.5/5.0
Pump on/off	No				Apr18-May3 & Jun7-13 =10in			=.84 ft
Pump on/off	No				Sept28-Oct9 & Oct31-Nov23			=1.15 ft
Total freshet	Lake peaks – ice off total+ 0 pumped = **4.7ft**/1.4m				Peaks (4.9+17.8+.4 ft pumped) =23.1 –ice off sum (18.1ft)= **5.0ft./1.5m**			5.0 ft/1.5m
Total pumped	None				.84 ft pumped before peak 1.15ft pumped after peak			1.99 ft/.60m
Next Capacity predicted	FSS-ice on totals= 23.5 ft.-17.9 ft.= 5.6 ft./1.7m.				FSS- ice on totals = 23.5-18.5= 5 ft.			5.0 ft/1.5m
Fall EUS	Peaks-pumped-ice on totals			4.75ft/1.4	Does not include water pumped.			3.55ft/1.08m
Add info.	SRW blockages & power problems to pump (transformer repaired 2x in 2016). Difficult to get to pump.				When spring pump on & Sept 28 to Oct 4 water also entering. If pump efficient releases .5 in/24 hr. Apr 24 water over spill. 4 in.deep.			

3.

Twin Lakes Annual Lake Levels/Watershed & Management Story

Triggers	Date 2017	UTL stor Ft/m	TP stor Ft/m	LTL Ft/m		Date 2018	UTL stor Ft/m	TP stor Ft/m	LTL Ft/m
Snow pack - April	150% OK	133% Summerland				206%			
Lake Ice off	Apr 17	2.1/.64	.57/.18	16.6/5.05					
SWLRC ice out	Apr 18	Debris blocked culvert							
Water to UTL	Apr 20			16.75/5.1					
Water over dam spillway	May 1	4.9/1.45	1.3/.4	16.75/5.1					
Water to LTL	May 2	4.9/1.45	1.45/.45	16.8/5.12					
Horn Creek stops	Jul 2	6.5/1.99	3.2/1.0	20.15/6.25					
Dam Spill. (sandbagged 1.5 ft.) stops	Jul 10	6.5/1.99 peaked	No WCG showing	20.17/6.1					
H20 to LTL stops	Oct 14			17.1/5.2					
Culvert open	Aug. 12	Open 1/2							
Culvert shut	Oct 2	1.65/.5	1.8/.55	17.55/5.34					
LTL Peak when 1.5' sandbag@dam+ 3.5"over spill	May 20	5.1/1.55	4.2/1.3	21.53/6.56					
Ice on	Dec14	1.9/.58	.79/.24	16.75/5.1					
Pump on/off electric	May9	Off Nov15							
Pump on/off Diesel	Jun 8	Off Sept 17							
Total freshet	Lake peaks – ice off total + pumped before peak + amt. of flood (28'-18.7'+.5'+3'= 13')			13ft/3.96m					
Total pumped	About 5 ft. - .5"x 4 mo.			5 '					
Next Capacity predicted	FSS-ice on totals 23.5' – 18.65'			4.85'					
Fall EUS	Peaks-pumped- ice on totals (28-5-18.65 = 4.35)		Used Historical	3 ' – due to water in??					

5.

2018 Monitoring Twin Lake Water Levels.

	2018 Triggers Twin Lake Waterway	Date Observed	Upper Twin Lake Storage (UTL)		Turtle Pond Storage (TP)		Lower Twin Lake (LTL) water level	
			Feet	Meters	Feet	Meters	Feet	Meters
1)	SnowPack 2018	208% N	LTL: 1" if lake is 80 acres = 8.9 acre ft = 2 900 074 US g.					
2)	Lake Ice Off	19-Apr-18	2.60	0.80	1.30	0.40	17.10	5.20
3)	SWLR Culverts ice off now blocked	13-Apr-18 large washout	2.10 culverts removed	0.64	1.20	0.38	17.10	5.20
4)	Water into UTL	13-Apr-18 2 in. deep	2.10	0.64	1.20	0.38	17.10	5.20
5)	Water over spillway UTL	22-Apr-18 2 in. full length	2.95	1.00	2.62	0.80	17.30	5.27
6)	Water into Lower Twin Lake	23-Apr-18 1/4 culvert flo	3.93	1.20	2.62	0.80	17.36	5.29
7)	Horn Creek no active flow to UTL	21-Jun-18	5.08	1.55	6.00	1.83	23.93	7.29
8)	Spillway (Nature Trust) not active	17-Jul-18	5.00	1.52	7.00	2.13	21.34	6.50
9)	Turtle Pond no flow to LTL	4-Dec-18	-1.00	-0.30	1.50	0.46	16.12	4.91
10)	North Strata road spill	1-May-18	LTL gained 5 in./day. April 30 was 10 in./day				19.65	0.60
11)	Natures Trust Culvert open	16-Jul-18	5.00	1.52	7.00	2.13	21.34	6.50
12)	Natures Trust Culvert closed	Feb-19	-1.00	-0.30	1.54	0.47	15.87	4.84
13)	Twin Lake Peak	23-May-18	6.50	1.98	10.00	3.05	26.78	8.16
14)	LNID Pump On	19-May-18	6.50	1.98	8.00	2.44	26.73	8.15
15)	LNID Pump Off	12-Dec-18	-1.00	-0.30	1.54	0.47	16.20	4.94
16)	Diesel Pump On	19-May-18						
17)	Diesel Pump Off	16-Nov-18					16.20	4.94
18)	Ice On	5-Dec-18	-1.00	-0.30	1.50	0.46	16.12	4.91
19)	May 4 a 39 in. culvert was installed ten ft. above the 48 in. Eastview Rd. culvert to ease up gradient pressure.							

		Feet	
20)	Total Freshet	17.10	From - change in peak flow indicated by change in gain for each water body, and subtraction of prior "ice-on" levels (Fall season of prior year)
21)	Fall Evapouration, Use and Seepage (see Botham Report)	3.00	Assumption taken from Preliminary Botham Report, 1973 average.
22)	Total Pumped	14.00	
23)	Projected next freshet capacity	8.50	Twin Lake flood trigger point elevation subtract Twin Lake level at ice on fall 2018 addition turtle pond available storage

2019 Monitoring Data Twin Lake Water Levels

	2019 Trigger Locations	Date Observed	Upper Twin Lake Storage (UTL)		Turtle Pond Storage (TP)		Lower Twin Lake (LTL) water level	
			Feet	Meters	Feet	Meters	Feet	Meters
1)	Snow Pack 2019	78% N	LTL: 1" if lake is 80 acres = 8.9 acre ft = 2 900 074 US g.					
2)	Lake Ice Off	7-Apr-19	0.25	0.80	1.10	0.35	15.90	4.80
3)	SWLR Culverts ice off now blocked	13-Apr-19 rocks filling culverts	0.43	0.13	1.10	0.35	16.00	4.90
4)	Water into UTL	no water into UTL						
5)	Water over spillway UTL	No water over 28-Apr-19	0.43	0.13	0.43	0.13	15.90	4.80
6)	Water into Lower Twin Lake	No surface water into LTL						
7)	Horn Creek no active flow to UTL	15-May-19 logging trucks	0.56	0.17	0.00	0.00	15.14	4.60
8)	Spillway (Nature Trust) not active	30-Jun-19 culvert open	small flo out UTL	0.00	-3.00 from WCG	-0.91	15.50	4.72
9)	Turtle Pond no flow to LTL	no flow to LTL in 2019						
10)	North Strata road spill	No as levels falling						
11)	Natures Trust Culvert open	30-Jun-19	0.00	0.00	-3.00 horizontal	-0.91	15.50	4.72
12)	Natures Trust Culvert closed	Nov 30-19	0.00	0.00	-3.00	-0.91	14.00	4.27
13)	Twin Lake Peak	30-Mar-19	0.42	0.13	0.82	0.25	16.25	4.95
14)	LNID Pump On	28-Mar-19	test 24 hr					
15)	LNID Pump Off	29-Mar-19						
16)	Diesel Pump On	No						
17)	Diesel Pump Off							
18)	Ice On	30-Nov-19	0.00	0.00	-3.00	-0.91	14.00	4.27

19)		Feet	Consider TLGR irrigation Mid April to Sept 30. Surface to ground water movement is latent.
20)	Total Freshet	minus 4	From - change in peak flow indicated by change in gain for each water body, and subtraction of prior "ice-on" levels (Fall season of prior year).
21)	Fall Evapouration, Use and Seepage (see Botham Report)	4 loss	~~Assumption taken from~~ Preliminary Botham Report, 1973 average. 3.5'
22)	Total Pumped	.25inch	
23)	Next freshet capacity 7' LTL + 3' UTL	10 ft.	Twin Lake flood trigger point elevation subtract Twin Lake level at ice on fall 2018 Turtle Pond some additional storage.

2020 Twin Lake Trigger Levels/Waterway Management

Triggers	**Date 2020**	**UTL storage Ft/m**	**TP storage Ft/m**	**LTL vertical Ft/m**
Snow pack /**Precipitation**	Feb 10 **132%N**	**Spring & fall rains ++**	March 27 **119%**	
LTL ice off	**Apr 15**	.49/.15	0/0	14.4/4.389
DL 1469s culverts ice out	**Apr 12** H20 for 40ft			
Water into UTL	**Apr 18**	.49/.15	0/0	14.4/4.389
Water over UTL spillway	**May 2**	**3.94/1.2**	0/0	**14.4/4.389**
Water into LTL	**May 5**	**3.94/1.2**	**3.28+ /1+**	**14.67/4.47 water above ER culvert grate**
Horn Creek stops	**Jun 4**	**3.11/.95**	**2.62/.8**	**17.08/5.20**
Spillway stop	**Jun 30**	**2.95/.9**	**1/3.28**	**17.76/5.41**
Water to LTL stops	**Oct 17**	**.656/.2**	**1.31/.4**	**17.9/5.45**
Dam open 20% **Culvert shut**	**Jun 30** **Oct.1**	.79/.24	1.97/.6	18.04/5.5
LTL Peak	**Sept 17**	**.820/.25**	**2.62/.8**	**18.2/5.54**
Ice -on	**Dec 17**	**.820/.25**	0/0	**17.118/5.217**
Pump on	**Sept 17**	**.820/.25**	**2.62/.8**	**18.2/5.54 rain++ pump from UTL & LTL**
Pump off	Dec. 17	**.79/.24**	1.24/..38	**17.118/5.217** **Water-in until Oct.17.**
Total Freshet	**peak (18.2 +.82) – ice off (14.4+.49) + ~4 EUS = 7.63 ft.**			
EUS	**~4 ft.**	**Varies with precipitation, temp., water use & ground water level.**		
Total pumped	**90 days at 1/8 in./day = 1.08ft.**			
Projected Next Capacity **Addition info**	**LTL has 2.1 ft. (flood at 19.2 ft) + UTL has 3.18 ft. = 5.28 ft.** **5.28 vertical ft.** **Dam culvert only opened 20%. Slow run with less force.** **Bottom load from many washouts & 2019-2020 clear cut logging+. May affect future water levels. Pump was away for repairs until Sept 17. Data Logger install Oct. 14.**			

2021 Twin Lake Trigger Levels/Waterway Management

Triggers 2021	**Date 2021**	**UTL stor Ft/m**	**TP stor Ft/m**	**LTL vertical Ft/m**	
Snow pack /precip.	Mar **118% N**	Apr.>N			
Lake Ice off	**Apr 4**	1.2/.38	.39/.12	16.8/5.12	
DL 1469s culverts ice out	**Apr 8**				
Water into UTL	**Apr 23**	1.4/.43	.95/.29	16.5/5.0	
Water to edge UTL spillway	**May 27**	3.28/1		16.2/4.9	
Water into LTL	Jun19	3.24/.99	1.14/.35	16.11/4.91	
Horn Creek stops	May15	2.88/.88	.59/.18	16.4/4.99	
Spillway stops	No H20 over				
Water to LTL stops in 33 days	**Jul 22**	2.3/.69	1.8/.55	15.55/4.7 ER culvert Blocked	
Dam culvert open/shut	**Jun 18** Shut **Oct 27**	Oct27 .95/.29	.0/.0	Oct27 15.53/4.73	
LTL Peak	**Jun 28**	2.88/.88	2.6/.8 ER blocked	16.22/4.9	
Ice -on	**Dec 12**	1.3/.4	-4/-1.2	15.3/4.6	
Pump on	**Mar 31**	1.2/.38	.39/.12	16.8/5.12	
Pump off	**May 6**	2.6/.8	.59/.18	16.37/4.98	
Total Freshet	.9'+.48'+assume 4'EUS =**5.38'**/1.6m				
EUS assum.	**4 ft or 1.2m**				
Total pumped	**0.4 ft LNID +.08 ft fire= 0.48 ft.**				
Projected Next Capacity	**6.6 ft**. (UTL 2.3 ft. + LTL 4.3 ft. to built infrastructure). FSS down 0.9 ft c/o 2020.				Eastview Rd. culvert was blocked with mud & stones to a level of about 1 ft. not visible from the road.
Additional Info.	2021 very hot dry spring/summer. July5 -Aug 15 most day highs 30 to 40C. Irrigation was 24/7 until Jul20. Peak data shows water ++ moved to ground from UTL –did not reach LTL.				

2022 Twin Lake Trigger Levels/Waterway Management

Triggers	Date **2022**	**UTL storage** Ft/m	**TP storage** Ft/m	**LTL vertical water level** Ft/m	
Snowpack /Precipitation	Feb. Report OK **84%N. Apr. S. OK 90%**	Spring & fall rains ++. Oct. hottest driest on record		Rain Mar 2 & Mar 14 to 19. Rain & wind all Spring.	
LTL ice off	**Apr 1**	1.3/.4	-3 ft/ .9m from Eastview Rd. Culvert	15/4.6	
DL 1469s culverts ice out	**Apr 1** H20 for 40ft				
Water into UTL	**May 2**	1.3/.4	-3ft./-.9m	14.8/4.5 H.C. Small flow to moderate flow to UTL.	TLGR irrigation Apr. 17 to Oct.25.
Water over UTL spillway	**May 30**	**2.95 ft/.9m**	1.57ft./.48m	**14.9/4.5**	Min. over to 1 in. over
Water into LTL	**May 16**	**2.6/.8**	**1.31/.4**	**14.81/4.47 water to ER culvert grate**	Wind++ Debris blocking ER culvert. Clearing all summer.
Horn Creek stops	**May 29**	**3.1/.95**	**1.57ft/.48m**	**14.9/4.5**	
Spillway stop	**Jun 27**	**3.2/.97**	**2.6/.78**	**15.7/4.8**	Washouts & blow downs at Bear/Horn Creek Confluence
Water to LTL stops	**Sept 22**	**-.6 ft./-.18m**	**1.31/.4**	**15.9/4.84**	Daily clearing of debris required.
Dam Culvert open	**Jun 22**	3.28 ft/1m zero spill	1.4 ft/0.43 m	15.57/4.75	Sept 29 no water in channel from UTL to dam. No UTL stor. of water.
Culvert shut	**Sept 30**	0.33 ft/0.1m below WCG	-0.33 ft/0.1m below WCG	15.86/4.83	
LTL Peak	**Jul 13**	**2.4/.74**	**1.64/.5**	**16.37/5m**	Jul 30 Keremeos Cr. Fire. Twin Lake Area on evac alert.
Ice -on	**Nov.30**	**No spill**	Low. Nov. 3 to 7 LTL had 2.6 ft. of snow	**15.51/4.7**	Logging++ Oct.1 – mid Jan 2023
Pump on Pump off	**Test only x2**			**No water pumped.**	Pump on for 1 min. x 2
EUS	**~ 4 ft.**		Varies with precipitation, temp., water use & ground water level.		
Total Freshet	**peak (LTL 16.37 ft. + UTL 2.4ft. – ice off UTL + LTL 16.3ft) + ~4 EUS = 6.47 ft.**				

Projected	**Capacity for 2023**	**LTL has 3.69 ft. (flood at 19.2 ft) + UTL has 4 ft. capacity**	**7.69 vertical ft. freshet capacity**	
Addition info	**Bottom load from many washouts & 2019-2022 clear cut logging required daily Eastview Rd. culvert clearing. May affect future water levels.**			

Legend:

WCG is Water Canada Gauge,

UTL is Upper Twin Lake,

TP is Turtle Pond,

LTL is Lower Twin Lake,

TL is Upper & Lower Twin Lake,

Stor. is live storage and MHC is Middle Horn Creek – from UTL outlet to TP.

EUS is evaporation/use & seepage which in 1973 average was 3 ft. but 2019 proved to be 4 ft. (2 ft. from each UTL & LTL).

DL 1469s culverts are at South White Lake Rd. ~ 1km above or south of UTL where Horn Creek leaves Orofino Mt. and enters a field.

Snowpack is predicted mid Feb., mid Mar., & mid Apr. at Mt. Kobau (1815masl) or Greyback Reservoir (1550 masl) snow pillows as Orofino Mt. is 1550 masl.

LTL has full lake supply (FLS) at 18.6 ft when water spills beyond the tree line.

Flood of built infrastructure at LTL begins at 19.2 ft.

Full System Supply (FSS) - UTL storage (licensed for 320 acre ft. which is ~4 vertical ft. on WCG before spill) + LTL 19.2 ft. at infrastructure flood level = 23.2 ft.

One vertical inch of LTL water when LTL is at ~ 80 acres or recommended high water level of 17.6 ft. is 2.173M US g. UTL & LTL area each about 80 acres but UTL is a shallow lake. LTL is 90 ft deep in the S. Bay.

LTL vertical water level is as the 1968 hydrometric station (Botham in 1973 stated normal should be a low of 12.6 ft to high of 17.6 ft).

TL waterway is formed by its geology and initially was used by 2 ranchers for gravity feed irrigation. In the spring water was stored behind the 1948 dam to flood the upper field. By June 30 the dam slide culvert was opened so that water moved into the LTL which overflowed or later (1951 to 1962) was released via a slide culvert on a gravity feed pipe to a lower field DL 280 & 281.