



# Memorandum

September 6, 2019

To: Eli Naffah, City Manager Ref. No.: 11198797

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**Subject: City of Trinidad**

**Conceptual Hydrological Assessment of the Luffenholtz Creek Watershed**

## 1. Purpose

The City of Trinidad's (City) water supply is from Luffenholtz Creek, which is subject to limitations based on the terms of the City's water right as it relates to flows in the creek. The flow in the creek varies significantly throughout the year. Multi-year droughts, other extractions from the creek, and long-term climate change can significantly reduce summer flows. It is possible that stream flows could diminish during dry periods to the point that the City's legal right to extract water is curtailed or drops to zero. This is not only a potential issue for considering future water supply requests, but it could affect existing customers as well. Treatment system characteristics also affect the City's ability to produce potable water; and storage and distribution system characteristics affect the City's ability to distribute water.

Potable water is an important resource and the City is in the process of developing policy related to water supply for both existing customers as well as potential future customers. The policy is expected to consider not only potential changes in demand over time, but also potential supply limitations.

The purpose of this memo is to provide a summary of some of the more significant issues associated with the City's extraction of water from Luffenholtz Creek. These insights are intended to help inform development of water policy by the City. It is the future policy that should guide the City in reviewing future water supply requests and guide the City during periods of curtailed supply.

This memo is divided into the following sections:

- Summary of Findings and Recommendations
- Background
- Watershed Characteristics
- Water Rights
- Historical Water Supply in Luffenholtz Creek
- Trinidad's Use of the Existing Water Right
- Future Water Supply in Luffenholtz Creek
- Concepts for Addressing the Extraction Zones



- Recommendations

## **2. Summary of Findings and Recommendations**

The following highlights the findings from this analysis:

- The City has a water right for a maximum extraction of 0.56 cfs (251 gpm)
- The City typically runs the water plant at about 70 gpm and may push capacity up to about 105 gpm
- The water right includes required bypass flows that must remain in the Creek
- The City recently installed equipment for continuous monitoring of bypass flows
- The flow conditions can be considered as Full Extraction, Curtailed Extraction, and No Extraction based on creek flow
- There is very limited data available for creek flow at the treatment plant and very limited data for extractions of water from the creek up- and downstream from the City extraction
- Based on the very limited data, it is known that the creek flows have been in the Curtailed Extraction Zone during very dry periods
- To date, it appears that limitations in the creek gravels, infiltration gallery, and wet well system have been the limiting factor on extraction rather than a curtailed water right
- Extracting water becomes increasingly more difficult with lower creek flows
- Climate change over the coming decades is expected to change precipitation patterns resulting in more runoff and less percolation as well as higher average temperatures and less fog, which could further reduce dry period flows and may also change demand characteristics.

The following highlights the recommendations from this analysis and the Water Loss Analysis (GHD 2019):

- Maintain continuous monitoring of bypass flows and provide improvements in data management to allow City staff better access to the data
- Further evaluate intake system to better understand limitations and to identify potential system improvements and operational changes to possibly increase intake capacity, especially under low creek flow conditions
- Develop policy for managing shortfalls in water availability (Caused by curtailed water right, practical extraction limitations, treatment limitations, emergencies, etc.)
- Consider potential water demands through 2100.
- Consider alternative long term sources of supply that mitigate the flow and extraction issues with Luffenholtz Creek
- Leak detection and replacement in aging distribution system.

## **3. Background**

Luffenholtz Creek is currently the only source of raw water that serves the City of Trinidad system. The City purveys water to approximately 1,000 people inside and outside City limits. The City's diversion and water plant is located at 1313 Westhaven Dr. Trinidad California adjacent to Luffenholtz Creek. Water for the plant is pumped from a wet well that is filled through an infiltration gallery of perforated pipes located



approximately ten feet below the creek bed. The point of diversion is just upstream of the Westhaven Dr. culvert. The City has current water rights limiting the rate of diversion, the annual maximum diversion, and requiring minimum bypass flows. In addition to water right limitations, the effective water production rates are limited by physical constraints in the processing of the water which include: infiltration gallery limitations, flocculator flow rates, filter fouling rates, backwash periods, and chlorine contact time requirements. In addition, the City has a relatively small amount of finished water storage that could supply typical uses for only a few days and is insufficient for bridging long term supply limitations. The treatment system capacity was addressed previously under a separate memo. The focus of this memo is on the watershed itself, which begins with a general understanding of watershed characteristics.

#### **4. Watershed Characteristics**

The Luffenholtz Creek watershed is located south of the City of Trinidad, and has a drainage area of approximately 2,880 acres and ranges in elevation from 225 to 1,370 feet (USGS 2019). Mean annual precipitation in the Luffenholtz Creek watershed is 60.8 inches (USGS 2019). Precipitation runs off to the ocean via Luffenholtz Creek or percolates into the ground. Water that percolates into the ground can later emerge into Luffenholtz Creek to sustain flows during the dry season. Soil types are predominantly silty to sandy clay loams derived from marine terrace sediments overlying Franciscan bedrock. Hydraulic conductivity is highly variable and ranges from approximately 1 to 20 meters/day in the marine terrace sediments to essentially zero in the underlying Franciscan bedrock materials. The higher porosity intervals of the marine terraces transmit the majority of the groundwater in the watershed. Groundwater elevations are variable and seasonal, however in the lower portions of the watershed groundwater is generally shallow and ranges from the ground surface to approximately 20 feet below the ground surface (bgs). The upland portions of the watershed have groundwater elevations ranging from approximately 20 to 100 feet bgs, depending on factors such as distance from the creek and the season.

Groundwater percolation is especially important for meeting water demands during low flow periods as it is the groundwater that feeds the stream during dry weather. Percolation and recharge of groundwater depends on many factors associated with the soils and geology as well as the frequency and intensity of storm events. Changes in precipitation patterns, even when the annual total remains the same, can significantly affect groundwater recharge and hence dry season creek flows.

#### **5. Water Rights**

California Water Law addresses a number of types of water use. People do not own water, but rather have certain rights to use water for reasonable beneficial purposes. Water use is regulated by the California Water Board. Of most relevance in this analysis of the Luffenholtz Creek watershed is the concept of Riparian and Appropriative water rights for surface water.

A riparian right exists on land that touches a water source and does not generally require an application to receive the benefits of the riparian right. Riparian rights usually come with owning a parcel of land that is adjacent to a source of water, and the rights generally remain with the parcel when it changes hands. Water obtained through a riparian right must be used on the property connected to the riparian right.



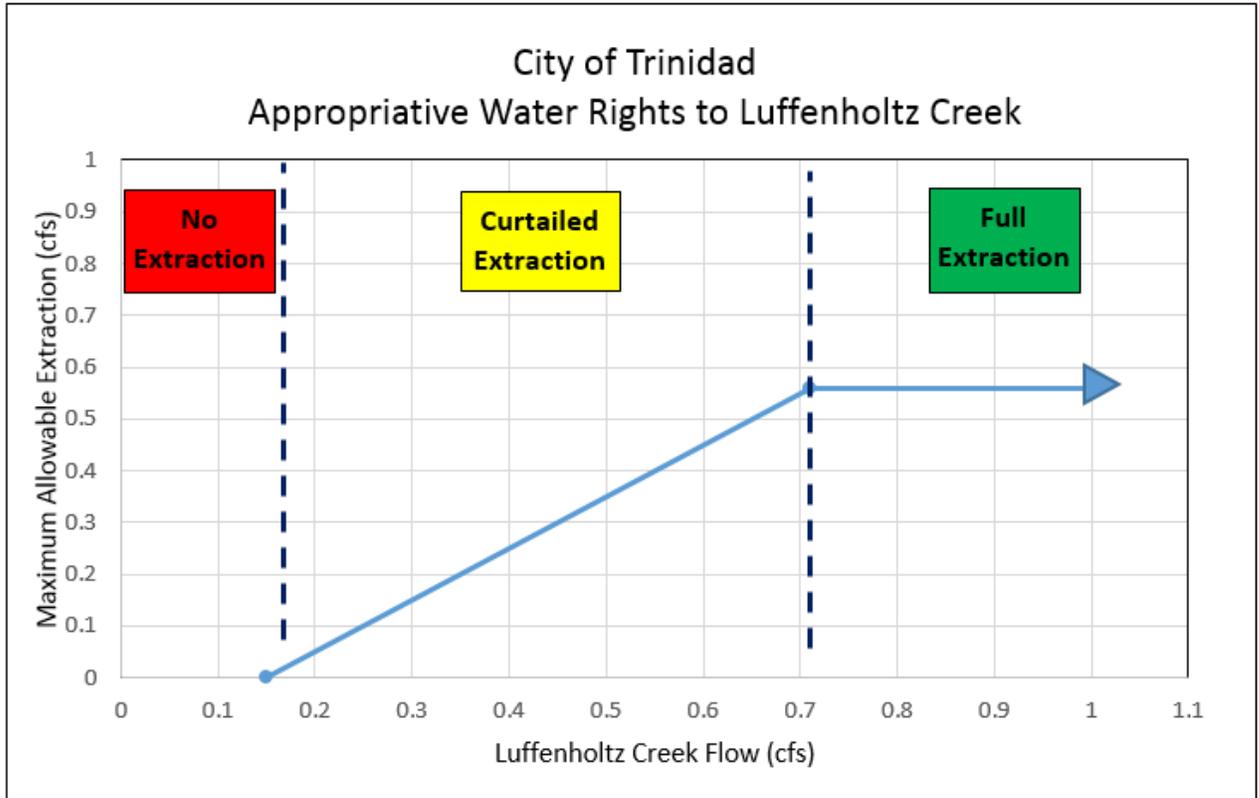
Riparian rights are not lost by non-use, but rather typically remain with the property adjacent to the water source. An unused riparian right is said to be "dormant" and use can be restarted at any time. All riparian right holders on a surface water source have the same priority. If there is not enough water available for the demands of all riparian users, then all users must share the available supply according to their needs. Generally, water used for interior domestic purposes, such as drinking, cooking and bathing, has the highest priority.

When water is to be extracted from a stream for use on non-riparian land then an appropriative right is required. Water right permits and licenses are issued by the State Water Board. There is an order of priority of appropriative rights based on the initial date of the water right. For example, an upstream junior water right holder must allow water to bypass to a downstream senior right holder.

The State Water Board in an effort to better understand water use throughout the state and provide information for water management by watershed has a system for reporting water use for all types of right holders. In some cases, the data gathered on water use, plus data from other sources can indicate to the State Water Board that there is a shortage of water in the basin and that all water rights cannot be fulfilled. The State Water Board can curtail water use of senior water right holders in critically affected basins, which was done during the drought of the late 1970's as well as during the most recent multi-year drought. These water right curtailments did not affect the Luffenholtz watershed, however the State could curtail the water rights on Luffenholtz Creek if deemed necessary.

A review of the State Water Board database for Luffenholtz Creek indicates there are at least three other appropriative rights holders and at least 14 other riparian parcels that submitted a Statement of Diversion and Use. The information in the database is incomplete as it depends on right holders to self-report, plus the program is relatively new and it is possible that not all water users are reporting or are not reporting accurately or completely. As time goes on, the State Water Board may be able to improve the amount and quality of data available in the database, which will help with watershed planning.

The City of Trinidad has two appropriative rights for a maximum extraction of 0.56 cubic feet per second (cfs) (251 gallons per minute) from Luffenholtz Creek through appropriative water rights permit numbers 15984 and 17255. Theoretically, the City has the right to extract up to a daily maximum of 361,440 gallons if the City extracted water 24 hours per day. The City is also subject to a bypass requirement as there is one senior downstream appropriative right and there is an expectation that a certain minimum amount of water is left in the creek. The City's water right stipulates that the City shall bypass 0.25 cfs except when the natural flow in Luffenholtz Creek is lower than 0.86 cfs and then the City must leave at least 0.15 cfs in the creek. From a practical standpoint, this means that the City can generally extract up to 0.56 cfs until the upstream flow drops to 0.71 cfs which is equivalent to 318 gpm (0.56 cfs plus 0.15 cfs) and then the amount the City can extract decreases as flows decrease. If the creek drops to 0.15 cfs or less, the City may not extract any water. The City's water right can be considered to have the three Zones of Full Extraction, Curtailed Extraction, and No Extraction as highlighted in the following figure.



## 6. Historical Water Supply in Luffenholtz Creek

The water supply in the watershed that feeds Luffenholtz Creek varies throughout the year based on weather patterns, extractions, soils and geologic characteristics, surface and groundwater, characteristics, and other factors. As is typical in the region, winter rains increase the flow in Luffenholtz Creek as directly related to individual storm events and over time as related to seasonal accumulation of precipitation in the region.

The peak flow events and seasonal high flow patterns supply ample water for many uses in the watershed. It is the low flow summer period, however, that is of most interest from a water supply standpoint for that is when water supply could become scarce and the City could see flows drop to a level where the City's allowable extraction could be curtailed. The City has been operating the water treatment plant under this summer low flow condition for decades and has adapted operations to allow for continued extractions and treatment of water to meet system demands (see previous memo on the current capacity of the water treatment plant). During the decades of operation, creek flows have been observed predominately qualitatively, although a number of periodic flow measurements have been taken over the years.

In 2001 a Water Supply Feasibility Study was completed for the City of Trinidad, and Technical Memorandum No. 8, Surface Water Technical Feasibility, highlighted a number of factors relating to water supply in Luffenholtz Creek. A summary of water supply characteristics are presented in this memo and the 2001 Technical Memorandum should be referenced for additional details.



Several previous studies have estimated the critical low flow in Luffenholtz Creek. A 1968 water supply feasibility study for the relocation of the Trinidad Water Plant from Mill Creek to Luffenholtz Creek by Winzler & Kelly, forecasted critical low flow in the Creek with a recurrence interval of 100 years. This value was estimated at 290 gallons per minute (0.646 cfs, 417,629 gpd) based on comparisons with Little River, which had a longer historical data set to work with. However, the use of Little River data is not necessarily representative of the Luffenholtz Creek critical low flows. The two watersheds vary in several key watershed components. The most obvious difference is size. The Little River watershed is 40.5 square miles, approximately 8.5 times larger than the Luffenholtz Creek watershed. This difference is important because it is likely that the Little River watershed maintains a greater amount of water in storage during periods of low flow. Thus, Little River data may over predict the low flow in Luffenholtz Creek. Additionally, the USGS gauge on Little River is located at a much lower elevation within the watershed than the Trinidad Water Plant's point of diversion. At lower elevations within the watershed the stream will be supplied with higher rates of base flow (groundwater) during summer months, will tend to have lower velocities, and the channel will widen out more like an estuary resulting in less dramatic high and low flows. In the higher elevations, such as are the characteristics of the Trinidad water extraction location, the drainage area tends to be steeper and the streams travel at a higher velocity and typically in a narrower channel with more dramatic flow variations.

A 1980 Trinidad Citizen's Report estimated the critical low flow in the Creek at 300 gpm (0.668 cfs, 432,030 gpm) based on 80 years of precipitation data in Eureka and Luffenholtz Creek low flow measurements in 1968 and 1977. The 1980 Citizen's Report also stated the lowest recorded flow in Luffenholtz Creek in the 1977 drought was 310 gpm. The frequency or method of the collection of these flow data is not known.

The Arcata Union newspaper ran an article about the 1977 drought in its September 8, 1977 issue. The Trinidad Public Works Director at that time, Tom Nelson, told the paper he measured the flow in Luffenholtz Creek at 284 gpm (0.632 cfs) the week prior to the article (confirmation of this could not be found in other sources, however). The City had predicted that Luffenholtz Creek would stop flowing by the end of August, but long periods of foggy weather and small amounts of rain were keeping the creek flowing. This article highlights the potential low flow conditions the City of Trinidad may confront in the future during drought conditions, which could be further exacerbated by climate change and other extractions from the watershed.

A previous search of the Department of Fish & Game files produced three stream surveys for Luffenholtz Creek. They were taken in November 1971, November 1975, and February 1982. These measurements were not taken during the driest part of the year and so they are not expected to represent the lowest flow periods. The lowest flow recorded in any of these surveys is 583 gpm, however this measurement was made in the upper portion of the watershed and may not represent flows at the treatment plant. The next lowest flow was 3,142 gpm near the water plant. The methods used by DFG to measure flows are unknown and the time period of the measurements was not the driest time of the year and so these measurements do not provide further insights into the potential critical low flow.

The City of Trinidad has measured flow on Luffenholtz Creek a number of times over the years. The City set up a weir in the early 1990's that was destroyed in a 1997 flood. Only one small data set from the fall of 1994 exists. The 1994 data is based on measuring the flow just below the intake of the water plant, and the total

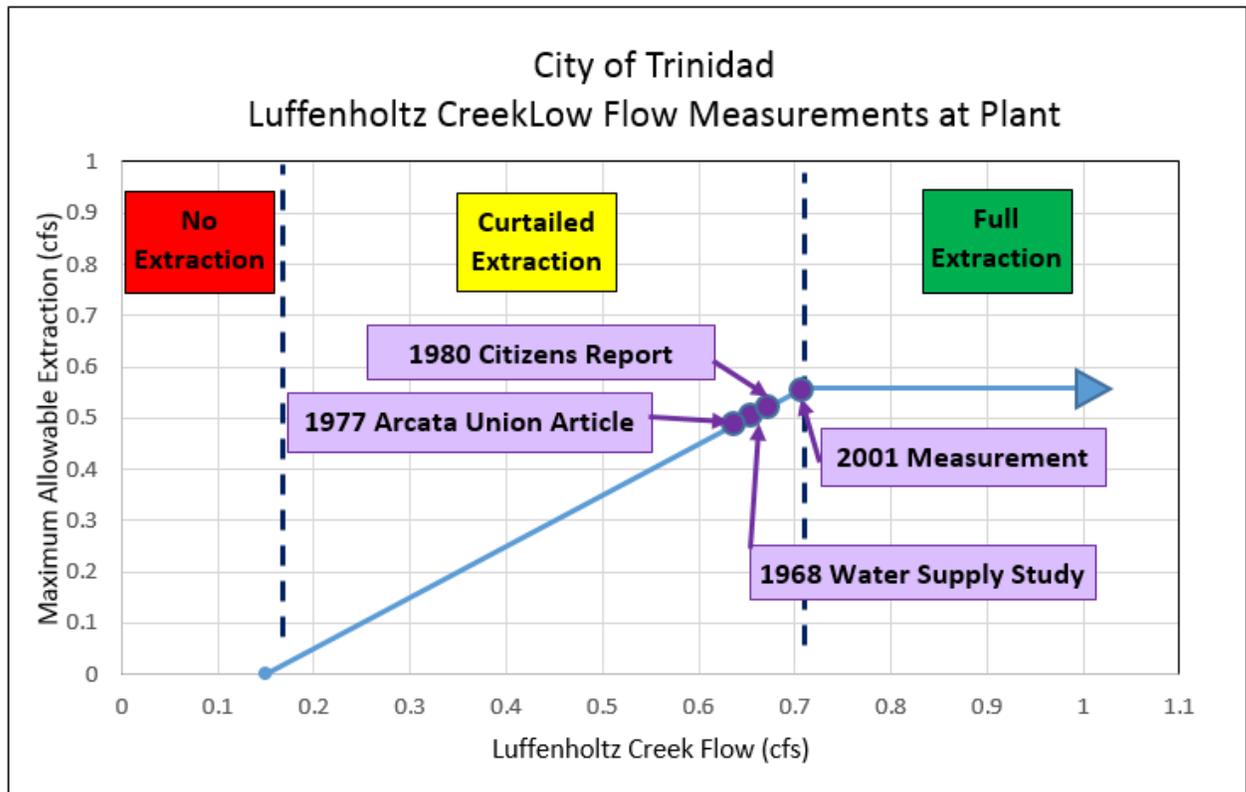


flow was calculated by adding the water plant flow to the measured flow. The 1994 flow data ranged from 421 gpm to 466 gpm (0.94 cfs to 1.22 cfs).

A new weir was constructed downstream of the water plant intake in the summer of 2001 for collecting data. Preliminary data from September of 2001 indicated that without the water plant pumps running, the creek flow was approximately 313 gpm or 0.70 cfs. This flow value is just under the City of Trinidad's water right plus bypass requirement. The flow in the watershed can continue to diminish in the fall months prior to winter rains and so it is possible that creek flows continued to drop before gaining again after the winter rains began.

Formal continuous flow monitoring over the life of the treatment plant has not been conducted in part due to the difficulty of obtaining continuous accurate measurements of low flow conditions. However, the State Water Board in recent history emphasized the importance of continuous flow monitoring and the City had flow monitoring equipment installed in the summer of 2017. Hence, the continuous monitoring began after the end of the recent multi-year drought, which ended in 2016, and so the data collected so far does not include the recent critical low flow drought period. The City should continue to monitor the flow in Luffenholtz Creek to build a better understanding of the flow characteristics of the creek under a variety of seasonal conditions.

Although the City has a water right to divert up to 0.56 cfs, the City must bypass a certain amount of flow, and low flow conditions may restrict allowable extraction. Periodic monitoring over a number of lower flow conditions over the past decades suggests that the creek flow can drop to levels where the City's extraction could be curtailed below the maximum water right. Four such low flow measurements are shown along with the water rights allowance in the following figure:



Although the City does not have flow data during low flow periods spanning the recent multi-year drought, creek flows may have been in the Curtailed Extraction Zone. Aside from drought, other longer term conditions including additional extractions from the creek as well as climate change could affect creek flows as further discussed in the next section.

## 7. Trinidad's Use of the Existing Water Right

The City can extract up to 0.56 cfs from Luffenholtz Creek which is just over 250 gpm. As was outlined in a previous memo, Water Treatment Plant Production Rate Test and Analysis (GHD, May 2019), the City typically extracts at approximately 70 gpm and the operators feel based on their experience that extraction could be increased to approximately 105 gpm during low flow periods. Theoretically, the City could legally extract significantly more water from the creek. However, there are a number of factors that may make this impractical. Aside from limitations in the overall treatment capacity previously highlighted, operational experience indicates that there are limitations in the infiltration gallery extraction system that may reduce the ability of the City to extract water. Operator experience has shown that during low flow periods it becomes increasingly more difficult to extract water. Under low creek flow conditions, water flow through the gravels and into the infiltration gallery and the wet well decreases and cannot keep up with maximum available pumping capacity. Hence the operational experience suggests a current limitation of approximately 105 gpm. To increase capacity, the operators can backwash the gravels with water and air during the wet season to clean the gravels of some of the sediments. However, this cleaning process is not practiced during low flow



periods due to the release of sediments from the gravels which would enter the relatively clean low flow stream.

What is not known is how low flows during Curtailed Extraction could further negatively affect extraction performance of the infiltration gallery. Even if water were available to legally extract, very low flow conditions may further hamper extraction capacity. For example, if creek flow were 0.5 cfs, the City could legally extract 0.35 cfs, which is more than twice the typical extraction rate under normal conditions. However, under such low flow conditions the infiltration gallery may not be able to pass this rate and potentially couldn't pass even the typical extraction rate. Further study of the capacity of the infiltration gallery under very low flow conditions should be conducted over time to better document the performance of the infiltration gallery and potentially lead to improvements under low flows.

## **8. Future Water Supply in Luffenholtz Creek**

The water supply in Luffenholtz Creek available to Trinidad could be further reduced in the future. It is expected that upstream extractions, future droughts, and climate change could result in flows more frequently dropping into the Curtailed Extraction Zone.

Future extractions in the watershed are very difficult to predict due to the nature of water rights, possible changes in water uses, very limited and incomplete data on historical extractions, and other factors. Riparian rights holders upstream have the right to reasonable beneficial use, which could include domestic and agricultural extractions or other beneficial uses. Although cannabis cultivation does include additional protections for water supplies, typical agriculture does not. Hence, riparian property owners could legally use additional water from upstream in the watershed. At this time, it is simply unknown how other extractions from within the watershed could affect the water supply for Trinidad, but it is assumed that existing upstream extractions are not likely to decrease over time.

The change in climate could likely have a significant long term effect on the amount of water available in the watershed for all beneficial uses. The effects of climate change have already been documented through analysis of historical climate data. A variety of models have been prepared to forecast the effects of continued climate change. Models suggest that average regional temperatures are expected to increase by three or more degrees Fahrenheit by mid-century. Precipitation models indicate a slight decrease in annual totals by the end of the century, but the patterns are expected to change to fewer larger storm events and greater runoff. In addition to precipitation, fog frequency is also projected to decrease. Although future coastal fog modeling is in the early stages of development, a study performed in 2010 found that over the 20<sup>th</sup> century there was an approximately 33% decrease in fog along the California coast and the occurrence of fog could further decrease this century. Furthermore, burned areas from area wildfires are likely to increase. The overall implication is that climate change over the coming decades will tend to make temperatures warmer, decrease the occurrence of fog, and change precipitation patterns. The change in precipitation patterns may have the greatest effect on Luffenholtz Creek Flows as it is the slow recharge of groundwater during the winter months that feeds the Creek during the summer months. Fewer more intense storms will tend to result in greater runoff and less percolation into groundwater.



With a variety of factors that are expected to reduce low flows in Luffenholtz Creek over the coming decades, the frequency of flows being in the Curtailed Extraction Zone are expected to increase. Due to the lack of accurate long term flow monitoring data and the future influence of factors affecting the watershed, the frequency, extent, and duration of such Curtailed Extraction periods is not known. However, it is generally known that flows continue to diminish during dry weather until regular seasonal precipitation events return. This suggests that if the City enters the Curtailed Extraction Zone early in the summer, that it could progressively become more significant for up to several months until regular rains return.

Also, as discussed in the previous section, although the City of Trinidad's actual typical water extraction is significantly less than the available legal water right, low flows in Luffenholtz Creek in the Curtailed Extraction Zone may reduce the effectiveness of the infiltration gallery system so that the City cannot practically extract the allowable amount or even the typical amount. Lower flows in the creek can simply reduce the achievable rate of extraction.

## **9. Summary of Concepts Associated with the Extraction Zones**

The concept of Extraction Zones was developed to illustrate the range of creek flows and allowable extraction rates based on the City's existing water rights. The concepts introduced in this analysis are summarized for the three Extraction Zones below.

### **Full Extraction**

Under a full extraction scenario, creek flows are above 0.71 cfs and in general it is expected that the City could reliably extract typical flows in the 70 to 100 gpm range. Even though the City has the legal right to extract at a higher flow rate, historically the City has not needed to extract at a higher flow rate to meet demands. Also, from an operational standpoint, the overall intake system performs better at the lower flow rate. It may be possible to extract at higher than the typical rate of 70 to 100 gpm, but hydraulic restrictions within the gravel bed, infiltration gallery, and wet well system tends to reduce the practical capacity. Based on separate studies, the City could have treatment capacity available beyond current demands when sufficient flow is available in the creek.

### **Curtailed Extraction**

The City's legal right to extract water from Luffenholtz Creek is curtailed when the total creek flow upstream of the City's infiltration gallery drops below 0.71 cfs and diminishes as creek flows decrease. Based on the very limited flow data available, it appears that drought conditions of the past have reduced creek flows to within the Curtailed Extraction Zone. However, the allowable extraction associated with these low flow data points is significantly higher than the typical rate of extraction and so such historical low flow occurrences may not have limited the City's ability to meet water demands at the time. It should be noted, that there was no flow data recorded from the most recent drought and so it is unknown how low the creek flow has recently been. The City's current monitoring of flows should be continued to comply with State Water Board requirements and to provide the City with ongoing information for operations.

It is also important to note in the flows in the Curtailed Extraction Zone are quite low and the limiting factor may not be the water right, but rather may be the ability of the gravels, infiltration gallery, and wet well intake



system to actually convey the water. Quite simply, the intake system does not operate very effectively at very low creek flows.

What should also be noted is that the Curtailed Extraction Zone is a narrow band of low flows and that climate change and associated changes in precipitation patterns along with potential changes in other extractions from the watershed may lead to more frequent low flow conditions that affect the water right and perhaps more significantly, the practical ability to extract water.

Low flow conditions in the curtailed Extraction Zone could last for weeks or months depending on the conditions. Depending on the severity and circumstances, this could result in a reduction in water available to meet customer needs. Such a condition would require rationing so that the water that was available could be distributed to customers as priorities warranted. This is a matter of setting water policy and developing implementation and enforcement measures.

### **No Extraction**

According to the City's water right, the City must bypass a minimum of 0.15 cfs and if the flow drops below 0.15 cfs, the City is not allowed to extract any water. Although no flows have been recorded below 0.15 cfs, it is possible that climate change and changes in precipitation patterns as well as other extractions in the watershed could lead to this situation under some conditions. If the City was in such a situation, the existing storage would last only a few days and may not be sufficient to bridge the shortfall until wet weather returned and increased creek flow so the City could extract water again.

## **10. Recommendations**

The City's current water supply from Luffenholtz Creek is subject to the requirements of the existing water right and the ability of the City to make adequate beneficial use of the right depends on creek flow at the City's intake as well as other factors such as treatment capacity, and storage and distribution capacity. The analysis in this memo was focused on the watershed, flows in Luffenholtz Creek, and extraction from the creek and the following recommendations are proposed to help address raw water supply issues and to better prepare the City for long term water supply:

The City began continuous monitoring of bypass flows several years ago and monitoring and reporting the State Water Board should continue. The data management system in current use is difficult for operations staff to access and it is recommended that improvements be made in data management to allow City staff better access to the data.

Since the intake system has capacity limitations under lower flow conditions, it is recommended that the intake system be further evaluated to better understand limitations and to identify potential system improvements and operational changes to possibly increase intake capacity.

Based on what is known about the watershed, the water rights, historical low flows, performance of the intake system, and the potential for other supply emergencies such as mechanical failures and natural disasters, it is possible there could be a shortfall in supply under some conditions. This potential for shortfall



exists today with current customers. It is recommended that the City develop policy for managing shortfalls in water availability. The City should also consider how much additional water to allocate to future customers. It is recommended that the City consider a planning horizon to the year 2100, which is the timeframe for typical climate change planning.

The watershed limitations and issues and extraction challenges under low flows cannot be completely mitigated without considering alternative sources of supply with different characteristics. It is recommended that the City investigate alternative long term sources of supply to improve long term system reliability. This is warranted to provide long term reliability to existing customers as well as future customers. Such an analysis should also include projections to 2100.