Report 1: Park Water Data

New strategies for reducing potable water use in parks and golf courses

Greenest City Scholars Program 2015
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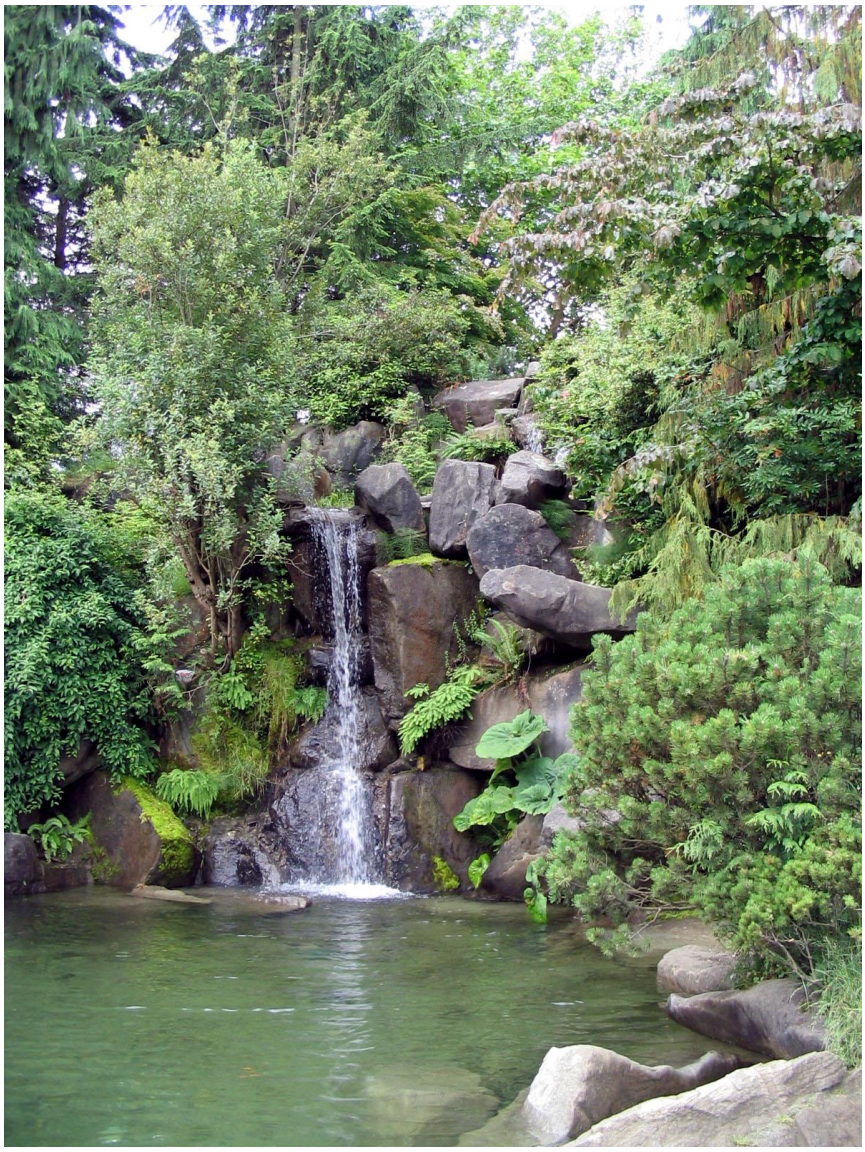
Mentor: Nick Page

July 30, 2015



Charleson Park Waterfall (Vancouver Park Board, 2005)

Recommendations

There has been tremendous work done to gather and organize water meter data for city parks. The proliferation of water meters and the use of AssetPlanner to make that data available are major steps forward. Based on the work completed for this report, a number of recommendations are presented for moving forward:

- **Measured Uses**
  - By far the biggest gap in the existing data is the lack of knowledge of what each water meter is actually measuring. Should it be possible to get this information (perhaps from meter shop technicians), a much more accurate calculation of current consumption, and a more specific characterization of the biggest water consumers could be determined.

- **Access to Data**
  - An attempt has been made in this report to explain the process by which water meter data travels through departments. There are a few aspects of this process (as understood) that could be streamlined:
    - In particular, meter data is collected one time per month, but only added to AssetPlanner every 3 months, as averaged values, which are later extrapolated to back to monthly values. Without much knowledge of why the data needs to be sent to Ameresco for upload to AssetPlanner, it would seem logical to make an attempt to push the meter data to AssetPlanner every month, perhaps directly from Tempest.

- **Reporting**
  - There is already a significant amount of data being collected on the parks water consumption; however without adequate access to this data it may not be useful. Furthermore, presenting and reporting that data in an effective way is vital for facilitating conservation actions. Some recommendations of how to do this using the current system include:
    - As part of the process of collecting data, and uploading it to Tempest, a report of meters that have measured consumption that is above or below their average can be created. This report should be sent to someone in the Park Board office who can follow up and identify the reasons for high consumption.
    - A monthly report of water consumption for each park, in comparison to comparable parks, and to historical consumption for that park would be ideal. This type of report is already created for energy use.

Overall, the water meter data for City parks is being routinely collected and all of the pieces required to support conservation actions are present. The challenge seems to be connecting those pieces, transforming the data into something useful for future planning, and getting it into the hands of the right person who can make those changes happen.

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1 Introduction

The number of water meters measuring potable water consumption in city parks has grown significantly over the past few years. Meters are read every month, and the data has the potential to improve the management of water in the parks, as well as more quickly and effectively identify leaks and high consumers. The data is not readily available however and access can be difficult. Furthermore, additional information about the meters, such as what they are measuring (eg. irrigation, swimming pools, fieldhouses, etc.), is not currently available formally (if at all).

This report discusses the data that is collected by the city on water consumption in parks. The data itself, the collection process, storage, access and the people involved are included, along with some recommendations.

A more in depth discussion of water consumption in the parks can be found in *Report 2: Parks Water Consumption and Data Gaps*, and an in depth look at the highest water consuming parks can be found in *Report 3: High Water Consuming Parks*.

2 Data Sources

There are numerous sources of data relevant to water consumption in city parks. While there is a lot of data that is theoretically possible to access, the reality is that it is not necessarily easily available, in a useful format, or important meta-data is missing. Substantial work has been done to match water meters from different databases which often have different names or addresses for the same meter. Overall, there is a lot of data on water consumption in the parks and the number of water meters has grown significantly over the past few years, the main challenge however, is the organization and access of that data.

2.1 Tempest

Tempest is a network database that contains all of the meter data for the city, and is primarily used for revenue meters[1]. The database includes not only water meters, but electricity as well, and contains a log of each meter reading since installation. For this report, the focus is on water meters for city parks which are non-revenue, but are on Tempest. More details about the data collection process are available in Section 3 below, but essentially each time a meter is read, the data is put onto Tempest. Also, calculations such as if water consumption for a particular meter is above or below normal are done in Tempest.

While the system contains a tremendous amount of data which is easily found based on account number or billing type (PARKS), there are some limitations. Most importantly the meter data can only be viewed one meter at a time, and data can only be downloaded for parks meters by route and by period (essentially by month) which makes it more work to compare consumption data between parks. Furthermore, the parks meter routes was changed in 2013.

[1] Revenue meters are water meters for paying customers (for example residential or commercial buildings). There is no billing for water using in city parks, so their meters are considered to be non-revenue.

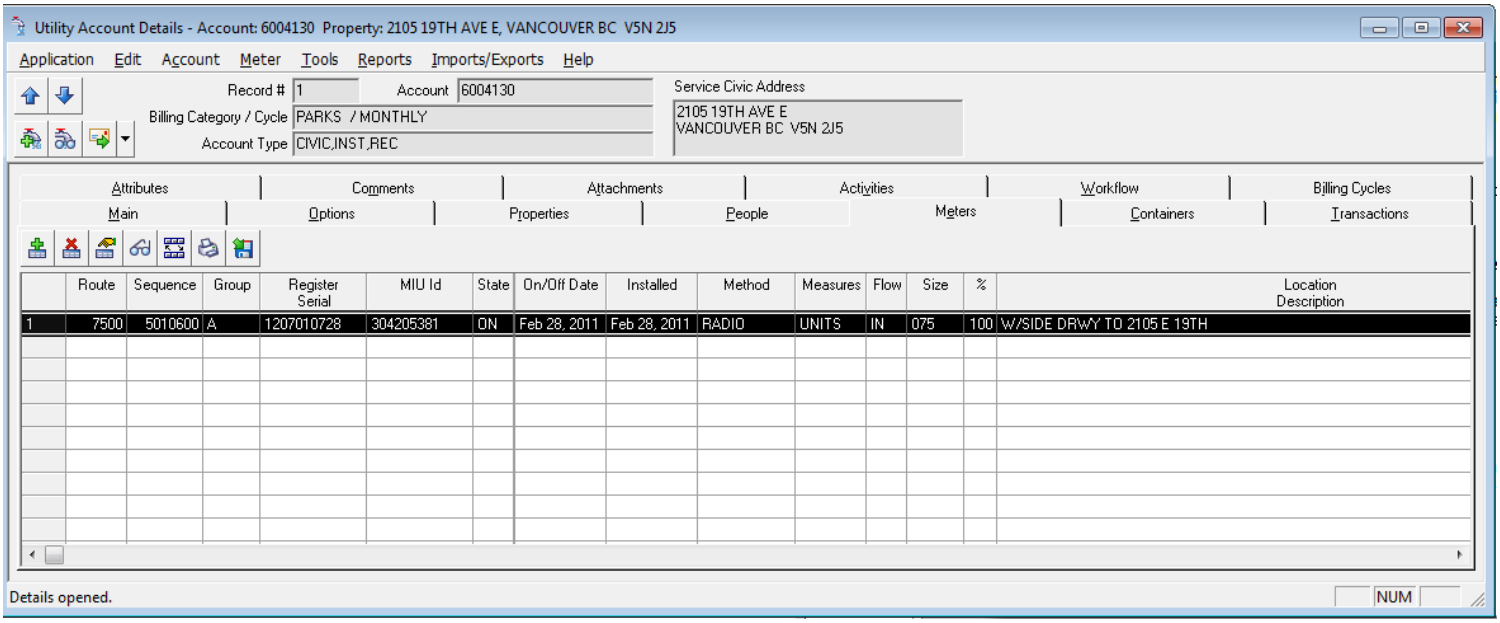

Figure 1: Screenshot of the Tempest Database.

2.2 AssetPlanner

AssetPlanner (formally FAME) is an online database built for energy meter data. This tool allows users to create graphical reports of energy use in city buildings easily and quickly. Water meters were added to AssetPlanner recently, and similar reports can now be completed. The main drawback of the current system is that the water meter data is not automatically uploaded from Tempest to AssetPlanner. The data must be uploaded into the database by Ameresco (the consulting firm that owns AssetPlanner) meaning.

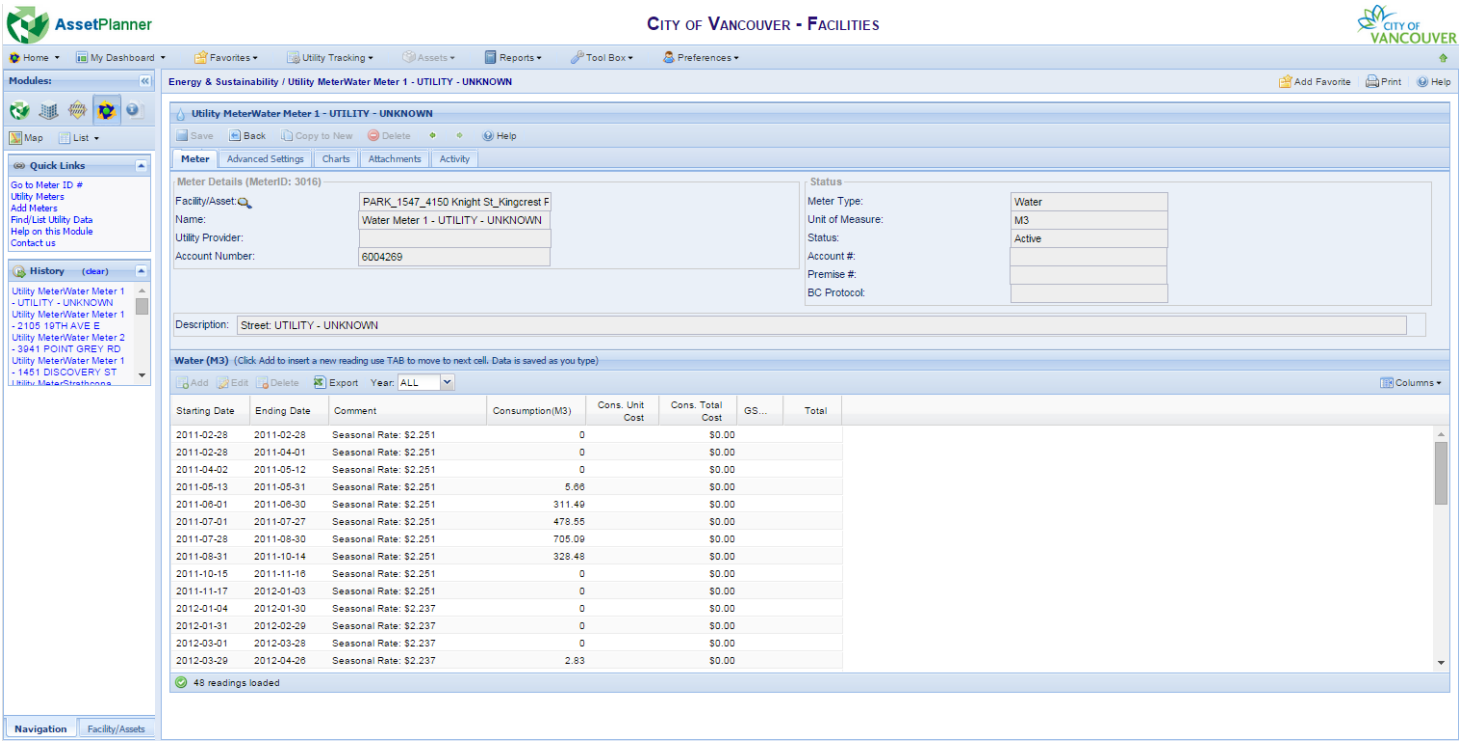

Figure 2: Screenshot of the AssetPlanner Database.

2.3 VanDocs

VanDocs also contains some water meter data in excel sheets. As explained in the next section, these files contain the raw data that is uploaded into AssetPlanner (ENG – WD – Water Quality – FAME Ameresco). Currently there are only three water meter data files using that naming convention:

- ENG - WD - Water Quality - FAME Ameresco - 2014-06-14 - All Water Meter Account readings
- ENG - WD - Water Quality - FAME Ameresco - 2014-12-10 - All Water Meter Account readings
- ENG - WD - Water Quality - FAME Ameresco - Nov 2014 to Mar 2015 - All Water Meter Account readings

Additional files were found on VanDocs containing water meter data for longer periods, using a different naming convention:

- ENG - WD - Water Quality - Parks Water Meter Readings - 2007-2012.xlsx
- ENG - WD - Water Quality - Facilities Water Meter Readings - 2006-2013
- ENG - WD - Water Quality - Facilities Water Meter Readings - Monthly Results - 2006-2013

The database name change from FAME to AssetPlanner may have led to a change in how the files are named, so these are not necessarily the only files on VanDocs with water meter data.

2.4 Other Relevant Data

2.4.1 Open Data Catalogue

The Open Data Catalogue has a comprehensive list of all of the City of Vancouver parks, and includes the facilities for each (fieldhouses, restaurants, community centres, etc.).

2.4.2 Facilities List

The *Facilities Recapitalization - Building List - Maintenance Portfolio Review* was provided by Ian Harvey from Real Estate and Facilities Management contains all of the Park Board owned facilities, and their maintenance condition.

2.4.3 VanMap

VanMap has a layer for municipal water meter locations, however not all of the park meters are included, and the meter locations for the parks is not accurate in some cases. The data for the map is in Tempest, and adding a layer for park meters should be straightforward as the coordinates for the meter locations is there already.

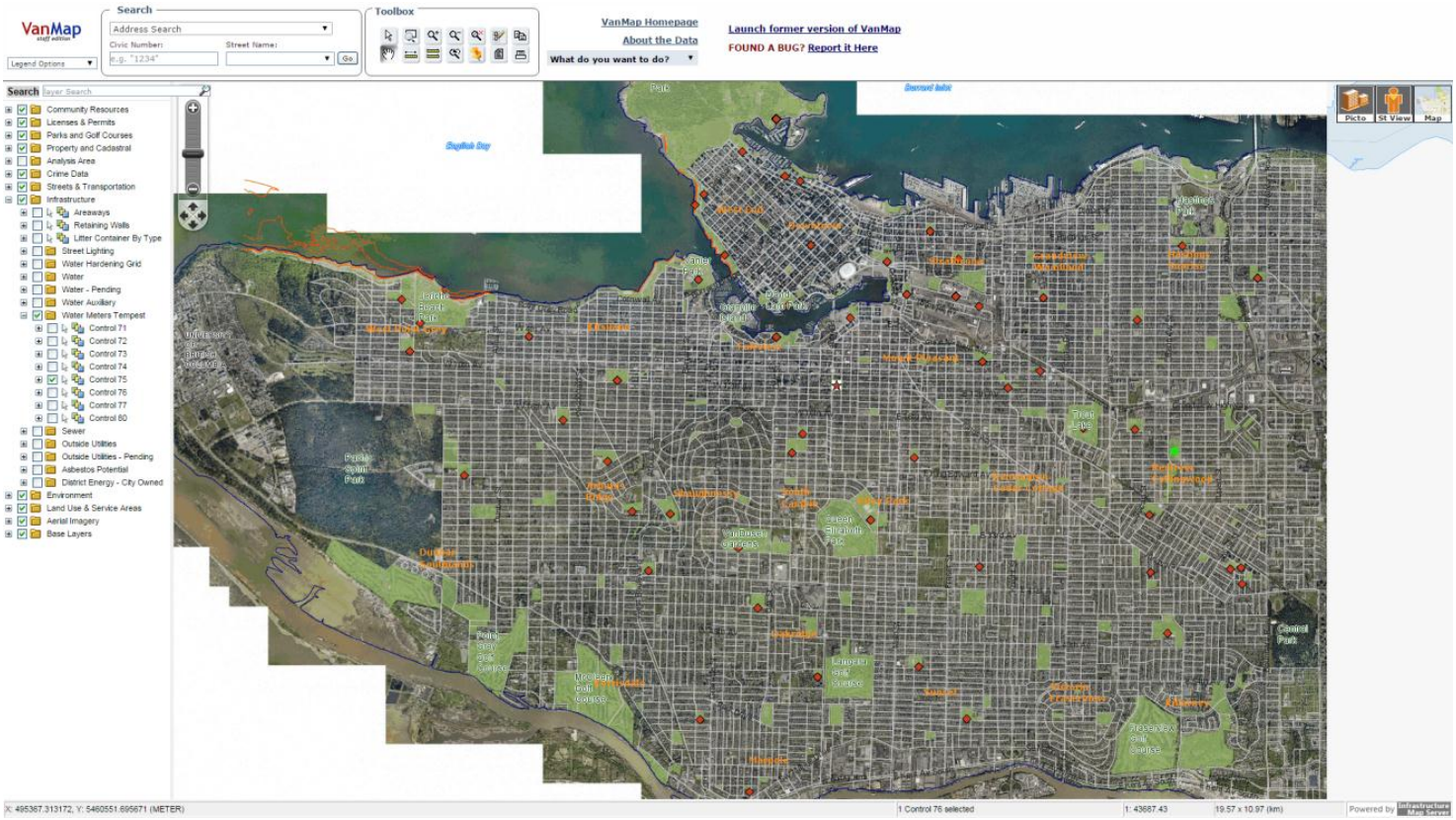

Figure 3: VanMap screenshot, showing Control 75 Tempest Water Meters.

3 Data Collection and Processing

A rough overview of the data collection process and how it gets to each database can be seen in Figure 4 on the next page.

There are 197 water meters for the Park Board on the Tempest database. These include meters that measure not only parks, but community gardens, Park Board owned restaurants, and other facilities such as the aquarium. The water meters are read 12 times per year (roughly once per month) which is important when looking at the data because the period it measures may vary significantly. The meters are read by radio, which involves driving a specially equipped van within close enough proximity to the meter to be able to receive the signal. The parks meter route usually requires two days to complete.

This system will not be in place forever, as meters with new radios are already being installed in some locations. These new meters have a much longer range (> 1km) which would allow them to be read by a tower – potentially every 6 hours. But this is nowhere near to being fully implemented – and is described here only to provide some insight into what might be possible with this data later.

The process of reading the water meters and processing the data can be seen in the upper box of the flow chart in Figure 4. First, the meter route (in this case it would be the parks, but it is the same process for all of the City's meters) is downloaded from the "network" to the truck computer (using a USB stick). The route is then completed,

with the meters being read by radio and the data being gathered by the truck computer. While the meters are being read, if a particular consumption value is higher or lower than normal (thresholds have been calculated for each meter by Brianne Winter), that meter is flagged on the computer, and later put in a report (see below). At the end of the route, the data is uploaded to the network where it is accessed by the Billing department. Billing then uploads the data to Tempest, and a report of the flagged meters is compiled and placed on the meter shop H: drive (only if requested by the meter shop).

Currently the water meter technician is Brianne Winter, who will be replaced at the end of June, 2015 by Vincent Narayan. Kyle van Veen reads the meters when Brianne is not available, and is also very knowledgeable about the system. Swapna Kamath is in charge of the report of flagged water meters (higher or lower than normal consumption).

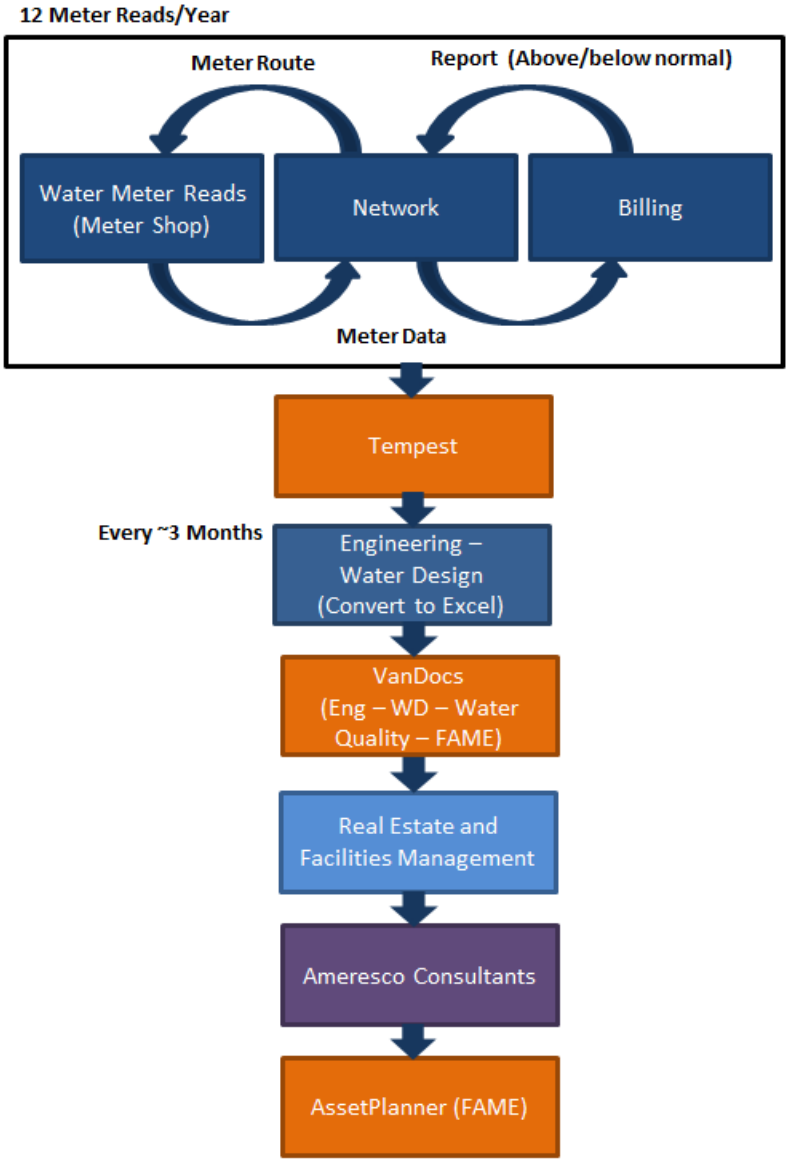

Figure 4: Flow chart of water meter data through City of Vancouver departments (based on information provided by Brianne Winter, Jennifer Bailey, Kyra Lubell and the VanDocs File: ENG - WD

- Water Quality - FAME Ameresco - Data flow from City water metering database to FAME). This process is in the process of change.

Once the data is in Tempest, someone (yet to be determined) from the Water Design department within Engineering retrieves the data every 3 months and converts it to an excel file (this was formally deon by Jeanette Keays). This file contains the total consumption values for the entire 3 month period, and not the monthly period that was initially measured. Once in excel the file is saved in VanDocs for the Water Quality Team (Eng – WD – Water Quality – FAME). That same file is also sent by Richard Tse or Craig Edwards from the Real Estate and Facilities Management (Environmental Planning) department to the Ameresco Consultants who upload it to AssetPlanner. Once in AssetPlanner, the data is sometimes extrapolated from 3 month values back to monthly values (not sure how this is done).

4 Coverage of Water Meters

All of the calculations for the data presented in this section can be seen in the accompanying document (Report 1 – Water Meter Data – Calculations).

The City of Vancouver has an extensive parks system comprising 215 parks many with one or more facilities. Table 1 shows the total number of metered and unmetered parks, as well as a breakdown of parks with and without facilities. It is important to note that a park was considered metered if a meter exists at the park location, but it is for the most park unknown what water consumption is covered by a particular meter. Because of this a metered park may not represent a park with all of its water consumption measured by a meter. Furthermore, metered parks include those that are in Tempest (which should be all of the meters), including some community centres.

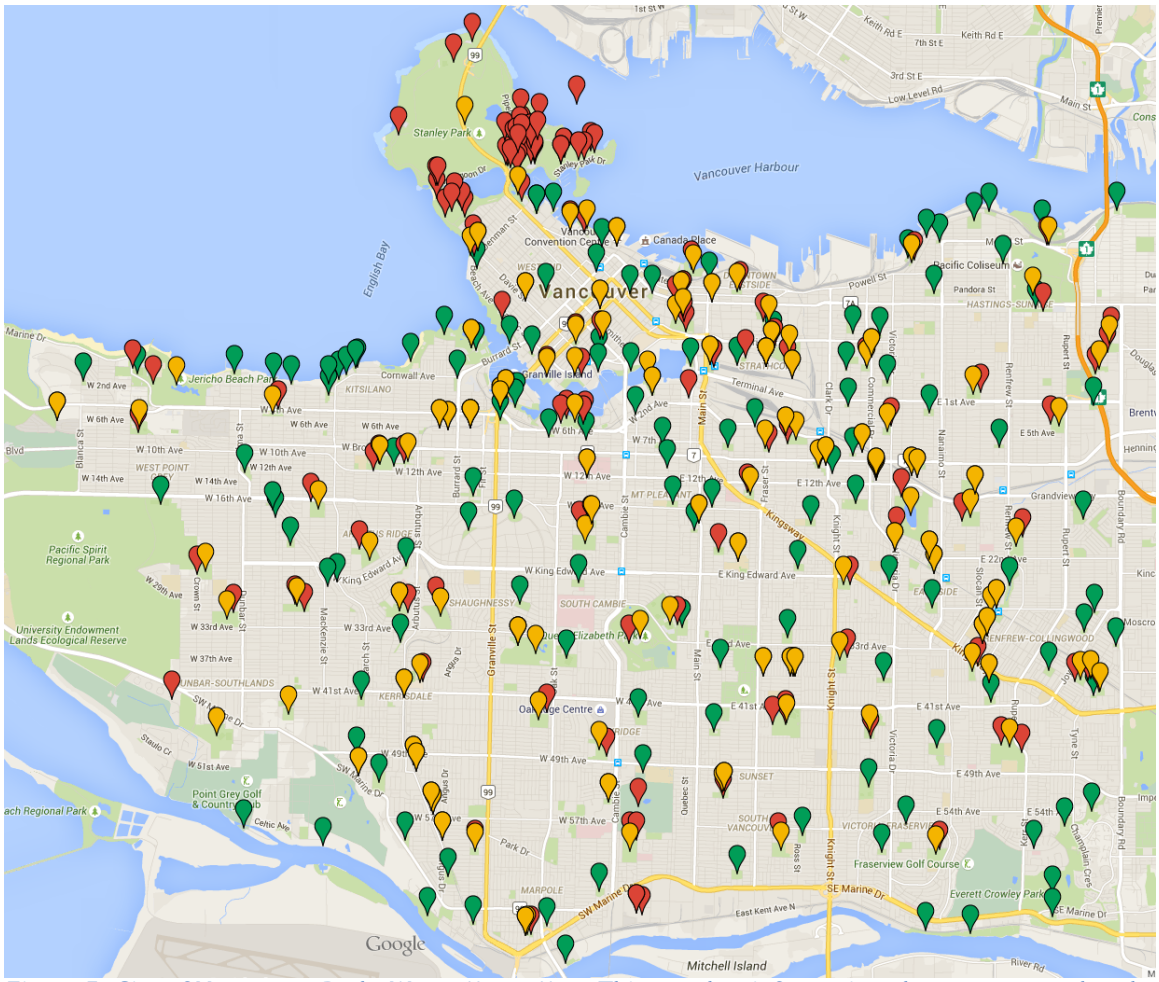

Figure 5: City of Vancouver Parks Water Meter Map: This map has information about unmetered parks (green), metered parks in Tempest (Yellow), and Tempest water meter locations (red). Available online: https://www.google.com/maps/d/edit?mid=z4w3ODpLPcKY.kVxBoVF-VEtM&usp=sharing.

The information from Table 1 can also be seen in the City of Vancouver Parks Water Meter Map created to illustrate the coverage of parks meters (Figure 5). The map also contains the actual meter locations based on the coordinates in Tempest, which are added as an additional layer (red). Additional meta-data such as the account number, address, and any other information such as the type of facility, if available, can be found in the online version of the map.

Table 1: Total Parks – Metered and Unmetered – for the purpose of this list, a park with a meter does not necessarily mean that the entire water consumption is measured.

Parks	Total	%	With Facilities		Without Facilities	
			Total	%	Total	%
Total	215	-	89	41.4	126	58.6
Unmetered	139	64.7	44	49.4	95	75.4
Metered	76	35.3	45	50.6	31	24.6

Table 2 shows the total number of each facility in the parks system. Unfortunately it is difficult to determine which are metered because only some of the meters are labeled

for a specific facility, but also it is unclear what the meters that are labeled actually measure. For example, a fieldhouse meter may include washrooms, irrigation, or just a utility sink. For this reason only the park facilities that can be confirmed as either having a meter or not are included, with the rest put in the 'unknown' column. Both tables are based on the Open Data Catalogue list of parks and their facilities which were matched with water meter names and addresses.

Table 2: City of Vancouver Park Facilities – Totals (Open Data Catalogue, H:Drive File: 100713 - Community Garden Inventory).

Facility	Total	Confirmed Metered		Confirmed Unmetered		Unknown	
		Total	%	Total	%	Total	%
Washrooms	94	6	6.4	32	34.0	57	59.6
Fieldhouses	58	26	44.8	21	36.2	11	19.0
Wading Pools	22	-	-	12	54.5	10	45.5
Food Concessions	15	4	26.7	4	26.7	7	46.7
Community Centres	14	11	78.6	3	21.4	0	0.0
Water/Spray Parks	14	4	28.6	4	28.6	6	42.9
Restaurants	11	6	54.5	1	9.1	4	36.4
Bowling Greens	11	2	18.2	5	45.5	4	36.4
Swimming Pools	9	4	44.4	2	22.2	3	33.3
Rinks	7	4	57.1	-	-	3	42.9
Community Halls	6	1	16.7	-	-	5	83.3
Golf Courses	5	4	80.0	-	-	1	20.0
Cricket Pitches	5	-	-	-	-	5	100.0
Community Gardens	88	24	27.3	-	-	64	72.7

4.1 Park Area

Park representing more than 80% of the total area of all parks has at least one water meter, the specific values can be seen in Table 3. In this instance, a park was deemed to be metered if it contains at least one water meter, but the entire water consumption of the park is not necessarily measured.

Table 3: Total metered and unmetered park area (Area data from Open Data Catalogue).

Parks	Area	
	Ha	%
Total	1347.22	-
Metered	865.06	64.2
Unmetered	482.16	35.8

4.2 Irrigation

For the majority of parks (especially those that do not have large facilities), irrigation is likely the greatest source of water consumption. Unfortunately, it is unclear which water meters include irrigation consumption, but Table 4 gives a rough idea of how

many parks have an irrigation system, and which are metered (2012 data). It is important to note that those parks in the table that are included as metered, only have a meter in that park, but it does not necessarily measure the irrigation. There are 152 parks with irrigation systems, and of those, 70% are on the city wide automated irrigation system, the rest are turned on and off manually.

Table 4: City of Vancouver parks with irrigation and the percentage with a water meter (VanDocs File: PB - REC - SP EV FLM - Vancouver Parks Irrigation Inventory - 2012.xls).

Parks	Total	% of Total Parks	Metered		Unmetered	
			Total	%	Total	%
Total	215	-	-	-	-	-
Without Irrigation	63	29.3	7	11.1	56	88.9
With Irrigation	152	70.7	69	45.4	83	54.6

5 Total Parks Water Consumption

A particularly challenging calculation has been the determination of the total annual water consumption by city parks. Calculations based on numerous assumptions have been done, and put the consumption around 2% of the total annual consumption for the entire city. Table 5 shows the estimated total and parks water consumption for 2013 and 2014.

The consumption for metered parks was calculated using the available Tempest data, and the average consumption of the metered parks was used as the estimate for the unmetered parks. This estimated average had a number of exceptions: Granville Island Water Park was assumed to have similar consumption to the Play Park in Stanley Park, and consumption for parks with no facilities or irrigation, as well as parks with no facilities, but with irrigation were determined by choosing similar parks that have meter data available and averaging their annual consumption. Unfortunately, there are very few representative parks, and thus only two parks for each category were used in the calculation, which represents a weakness in the estimate (See Calculations report for more details, along with an alternative – but less accurate – attempt to calculated total consumption using area).

Table 5: Total estimated water consumption for City parks excluding recreational facilities. City values are based on the VanDocs File: ENG - WD - Water Consumption Account Trending 2014 2013 2012 2011, parks metered values are based on Tempest data directly, and unmetered values are estimated based on Tempest data. It is important to note that the meters do not necessarily measure all of the park water consumption, making these estimates likely lower than in reality.

Total	Total Consumption (m3)	
	2013	2014
City of Vancouver	112,326,378	112,954,380
Parks	1,781,666	1,761,111
% of Total	1.59	1.56
Metered	1,427,835	1,444,923
Unmetered	353,831	316,188
% Metered	80.14	82.05

It is important to keep in mind that the available meter data does not necessarily measures all of the park consumption. The metered park consumption values are likely lower than in reality due to this fact, which also makes the unmetered estimates likely lower as well. The total consumption value presented is the sum of both the metered and estimated unmetered consumption.

Report 1:
Water Meter Data - Calculations

New strategies for reducing potable water use in parks and golf courses

Greenest City Scholars Program 2015
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Mentor: Nick Page

July 7, 2015

1 Calculations

1.1 Table 1: Total Parks – Metered and Unmetered

Table 6: Total Parks - Metered and Unmetered - for the purpose of this list, a park with a meter does not necessarily mean that the entire water consumption is measured.

Parks	Total	%	With Facilities		Without Facilities	
			Total	%	Total	%
Total	215	-	89	41.4	126	58.6
Unmetered	127	59.1	33	15.3	94	43.7
Metered	88	40.9	56	26.0	32	14.9

Total Parks: Value from the Open Data Catalogue list of City parks. The scope of this report is only parks from this list (excludes for example community centres that do not have a park).

With/Without Facilities: Values from Open Data Catalogue list of City parks. There was some discrepancy with the meter accounts (for example some parks have a meter labeled for a fieldhouse, but no fieldhouse listed in the Catalogue)

Metered/Unmetered: Determined based on meter accounts present in Tempest (meter route 7500) and AssetPlanner (FAME) – matched by account number. If a meter existed in a park (no matter what it measures) that park was deemed to be 'metered'.

1.2 Table 2: Specific Park Facilities

Table 7: City of Vancouver Park Facilities - Totals (Open Data Catalogue, H:Drive File: 100713 - Community Garden Inventory).

Facility	Total	Confirmed Metered		Confirmed Unmetered		Unknown	
		Total	%	Total	%	Total	%
Washrooms	94	5	5.3	32	34.0	57	60.6
Fieldhouses	58	26	44.8	21	36.2	11	19.0
Wading Pools	22	-	-	12	54.5	10	45.5
Food Concessions	15	4	26.7	4	26.7	7	46.7
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Rinks	7	4	57.1	-	-	3	42.9
Community Halls	6	1	16.7	-	-	5	83.3
Golf Courses	5	4	80.0	-	-	1	20.0
Cricket Pitches	5	-	-	-	-	5	100.0
Community Gardens	88	24	27.3	-	-	64	72.7

This list of facilities is based on data from the Open Data Catalogue – except for the Community Gardens which are based on the Community Garden Inventory.

Confirmed metered: These are meter account with labels for a specific facility (for example a fieldhouse meter).

Confirmed unmetered: These are facilities in parks that do not have a meter at all.

Unknown: There are facilities in parks that have a meter – but it is not clear if the meter measures the facility (unclear what the meter measures).

1.3 Table 3: Park Area

Table 8: Total metered and unmetered park area (Area data from Open Data Catalogue).

Parks	Area	
	Ha	%
Total	1347.22	-
Metered	1089.34	80.9
Unmetered	257.88	19.1

Total: Data from Open Data Catalogue

Metered/Unmetered: A park's irrigation was determined to be 'metered' if there is a meter in that park – even though the meter does not necessarily measure the irrigation.

1.4 Table 4: Irrigation

Table 4: City of Vancouver parks with irrigation and the percentage with a water meter (VanDocs File: PB - REC - SP EV FLM - Vancouver Parks Irrigation Inventory - 2012.xls).

Parks	Total	% of Total Parks	Metered		Unmetered	
			Total	%	Total	%
Total	215	-	-	-	-	-
Without Irrigation	63	29.3	7	11.1	56	88.9
With Irrigation	152	70.7	81	53.3	71	46.7

Total/With/Without Irrigation: Data from Vancouver Parks Inventory – 2012.

Metered/Unmetered: A park irrigation system was determined to be 'metered' if there is a meter in that park – even though the meter does not necessarily measure the irrigation. A park was determined to have unmetered irrigation if they have no meters at all, and therefore the irrigation is definitely not metered.

1.5 Table 5: Total Estimated Consumption (Parks)

Table 5: Total estimated water consumption for City parks excluding recreational. City values are based on the VanDocs File: ENG - WD - Water Consumption Account Trending 2014 2013 2012 2011, parks metered values are based on Tempest data directly, and unmetered values are estimated based on Tempest data. It is important to note that the meters do not necessarily measure all of the park water consumption, making these estimates likely lower than reality.

Total	Total Consumption (m3)	
	2013	2014
City of Vancouver	112,326,378	112,954,380
Parks	1,781,666	1,761,111
% of Total	1.59	1.56
Metered	1,427,835	1,444,923
Unmetered	353,831	316,188
% Metered	80.14	82.05

Total (City of Vancouver): From Water Consumption Trending File

Parks: Based on total of all metered consumption in Tempest (route 7500) + estimated unmetered consumption. This value excludes the UBC Endowment meter.

Metered/Unmetered: Based on the average water consumption of metered parks (the average annual consumption for all metered parks (with some parks excluded) was determined based on the Tempest data, and was multiplied by the number of unmetered parks). There were exceptions: Granville Island Water Park was assumed to have the same (high) consumption as the Stanley Park play park, and unmetered parks with no irrigation or facilities, or just irrigation, were assumed to have the same annual consumption as similar metered parks.

Values

Average Parks:

Average Annual Consumption (2013 & 2014): 1200 units
Total Unmetered Park in this Category: 32
Total Estimated Consumption 2013: 38400 units
Total Estimated Consumption 2014: 38400 units

Average Excludes: Charleson Park III, Trout Lake, Stanley Park – Play Park, Stanley Park – Rowing Club North, Stanley Park – Train West, Stanley Park – Lost Lagoon, Stanley Park – Aquarium, Musqueam Park, UBC Endowment.

No Facilties/No Irrigation:

Average Annual Consumption (2013): 31 units
Average Annual Consumption (2014): 43.5 units
Total Unmetered Park in this Category: 56
Total Estimated Consumption 2013: 1,736 units
Total Estimated Consumption 2014: 2,436 units

Average Based on: McSpadden Park, Oxford Park

No Facilties/With Irrigation:

Average Annual Consumption (2013): 1,278 units
Average Annual Consumption (2014): 973 units
Total Unmetered Park in this Category: 36
Total Estimated Consumption 2013: 46,008 units
Total Estimated Consumption 2014: 35,028 units

Average Based on: China Creek North Park, Arbutus Greenway Park

Water Parks (only for Granville Island):

Average Annual Consumption (2013): 38,814 units
Average Annual Consumption (2014): 35,800 units
Total Unmetered Park in this Category: 1
Total Estimated Consumption 2013: 38,814 units
Total Estimated Consumption 2014: 35,800 units

Average Based on: Stanley Park – Play Park

Totals:

Total Unmetered (2013): 124,958 units (353,831 m3)
Total Unmetered (2014): 111,664 units (316,188 m3)

1.6 Table 6: Alternative Total Estimated Consumption (Parks) - Area

Table 9: Total estimated water consumption for City parks excluding recreational facilities – estimated using consumption by area. City values are based on the VanDocs File: ENG - WD - Water Consumption Account Trending 2014 2013 2012 2011, parks metered values are based on Tempest data directly, and unmetered values are estimated based on Tempest data. It is important to note that the meters do not necessarily measure all of the park water consumption, making these estimates likely lower than reality.

Total	Total Consumption (m3)	
	2013	2014
City of Vancouver	112,326,378	112,954,380
Parks	2,258,280	2,029,220
% of Total	2.01	1.80
Metered (Tempest)	1,427,835	1,444,923
Unmetered (Estimate)	830,444	584,297
% Metered	63.23	71.21

Total (City of Vancouver): From Water Consumption Trending File

Parks: Based on total of all metered consumption in Tempest (route 7500) + estimated unmetered consumption.

Metered/Unmetered: Based on the average water consumption of metered parks (the average annual consumption for all metered parks (with some parks excluded) was determined based on the Tempest data, and was multiplied by the number of unmetered parks). There were exceptions: Granville Island Water Park was assumed to have the same (high) consumption as the Stanley Park play park, and unmetered parks with no irrigation or facilities, or just irrigation, were assumed to have the same annual consumption as similar metered parks.

Values:

Average Parks:

Average Annual Consumption (2013 & 2014): 805.4 units/Ha
Total Unmetered Park Area: 136.44 Ha
Total Estimated Consumption 2013: 109,889 units
Total Estimated Consumption 2014: 109,889 units

Average Excludes: Charleson Park III, Trout Lake, Stanley Park, Musqueam Park, UBC Endowment.

No Facilties/No Irrigation:

Average Annual Consumption (2013): 1,361.4 units/Ha
Average Annual Consumption (2014): 456.8 units/Ha
Total Unmetered Park Area: 84.71 Ha
Total Estimated Consumption 2013: 115,326 units
Total Estimated Consumption 2014: 38,695 units

Average Based on: McSpadden Park, Oxford Park

No Facilties/With Irrigation:

Average Annual Consumption (2013): 796.3 units/Ha
Average Annual Consumption (2014): 598.0 units/Ha
Total Unmetered Park Area: 36.73 Ha
Total Estimated Consumption 2013: 29,249 units
Total Estimated Consumption 2014: 21,965 units

Average Based on: China Creek North Park, Arbutus Greenway Park

Water Parks (only for Granville Island) – Same as previous estimate:

Average Annual Consumption (2013): 38814 units
Average Annual Consumption (2014): 35800 units
Total Unmetered Park in this Category: 1
Total Estimated Consumption 2013: 38814 units
Total Estimated Consumption 2014: 35800 units

Average Based on: Stanley Park – Play Park

Totals:

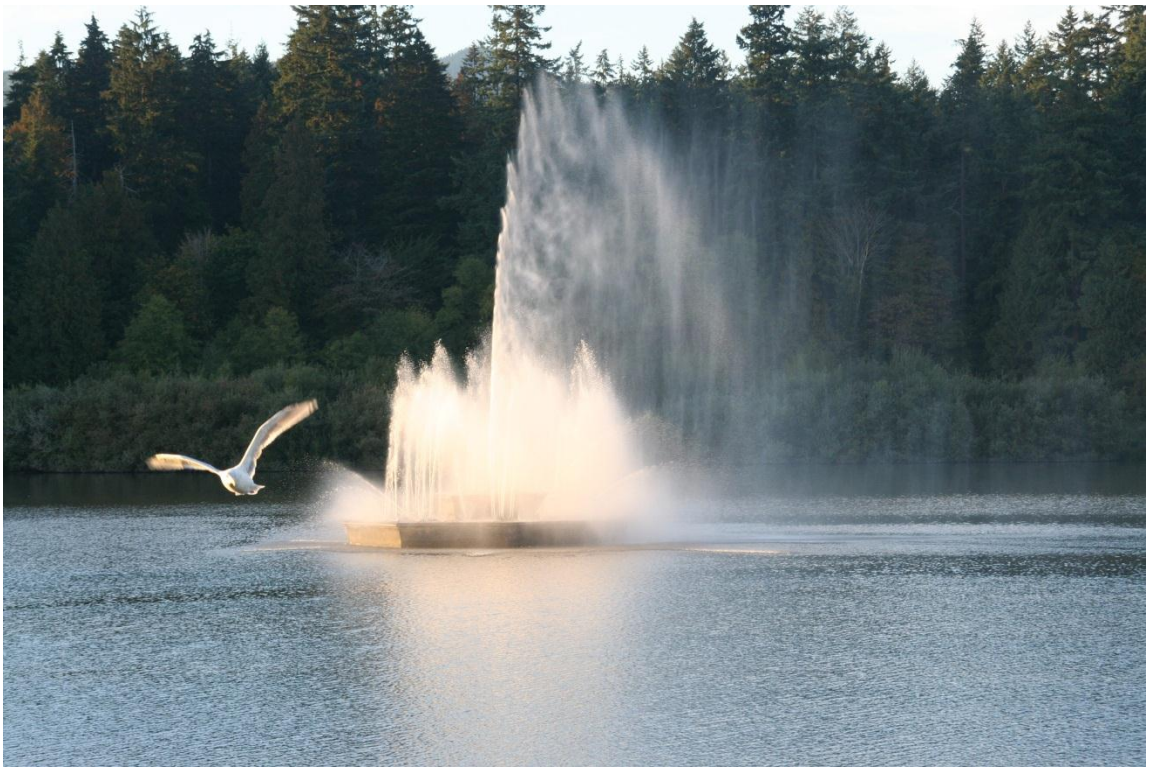
Total Unmetered (2013): 293,278 units (830,445 m3)
Total Unmetered (2014): 206,349 units (584,297 m3)

Report 2: Parks Water Consumption and Data Gaps

New strategies for reducing potable water use in parks and golf courses

Greenest City Scholars Program 2015
Daniel Klein
Mentor: Nick Page

July 30, 2015



Stanley Park, Lost Lagoon Fountain (City of Vancouver, 2009)

Recommendations

A number of recommendations for which City parks should be targeted for water conservation measures in order to have the greatest impact on total water consumption, as well as how best to address data gaps.

- **Target the highest water coming parks for conservation measures**
  - Audit (or even just look closely) the highest consumers in order to understand where the water is being consumed and why
    - This process may also identify leaks, waste, efficiency improvements.
  - Constant High Consumers:
    - Audit water use, and look into changing the management practices if applicable.
  - Seasonal High Consumers:
    - Audit water use
    - Set up systems that turn off water when it's not needed (no need to irrigate if it is raining)
    - Examine management of water, perhaps water parks could reduce working hours, and be turned off completely when raining.
  - Single Event High Consumers:
    - Monitor parks water consumption (get high consumption reports from meter shop after meter read)
    - Follow up on parks that have had a single high consumption event to learn more about why it happened, if it could have been prevented, and in order to try to prevent similar events in the future (if relevant: some may be on purpose – new fields, filling a pool, etc.)
    - Some single events seem to be issues with the data (for example an anomaly seen in a number of parks for November 2013), so ongoing monitoring of the data could resolve those issues.
- **Fill gaps in meter data**
  - Prioritize parks that have irrigation system and facilities (for example Falaise Park, Kitsilano Beach Park, Nanaimo Park, among others). See the accompanying excel file: Unmetered Parks.xlsx.
  - Prioritize metering facilities that are high consumers, water parks, etc.
  - Look into improving metering coverage of existing metered parks. This would require knowledge of what is currently metered to determine what water consumption is not covered.

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1 Introduction

Potable water consumption in City parks is dominated by a handful of parks. For the years 2013 and 2014, only 10 parks accounted for over 70% of the total water consumption for all metered parks in the City. This report will discuss the water consumption in the park, examine those parks that are consuming significantly more water than the rest, and identify gaps in the current water metering program.

An in depth look at the water data for the parks can be found in *Report 1: Park Water Data*, and a specific examination of the highest water consuming parks can be found in *Report 3: High Water Consuming Parks*.

2 Consumption in Parks

Perhaps the best illustration of how water consumption is distributed among the City's parks can be seen in Figure 6 that shows the average annual water consumption for all parks in the City that have a water meter. It is clear from the chart that water consumption is dominated by a few high water consuming parks. The distribution is so skewed that the average water consumption is not a representation of a typical park, which is why the median was also included.

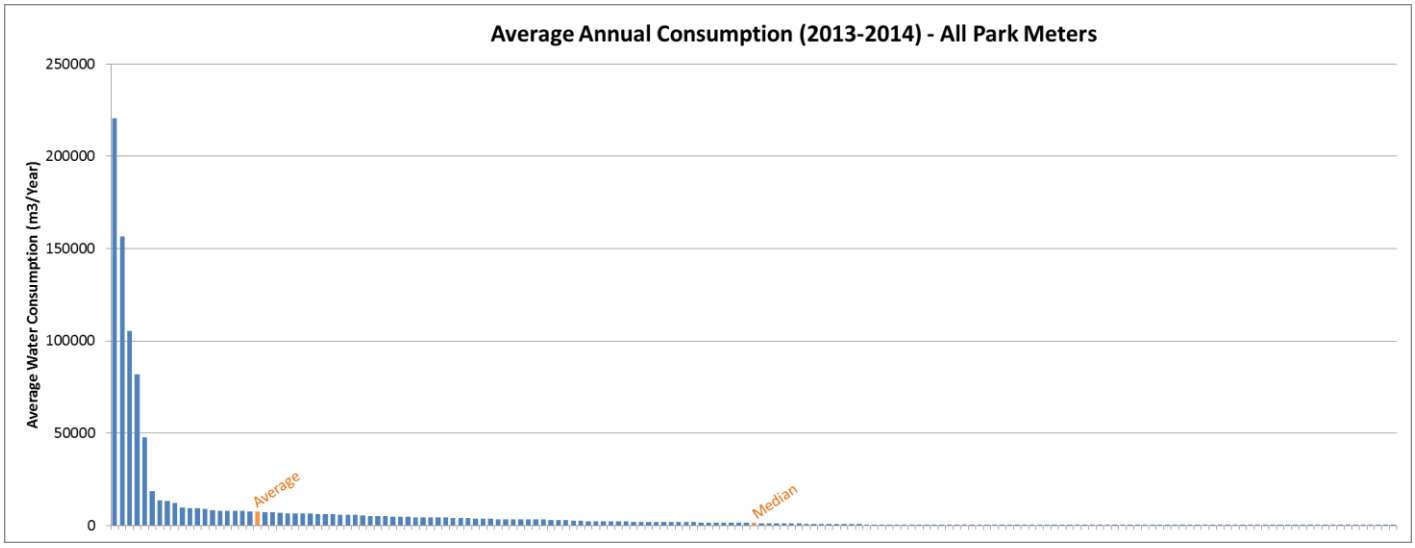

Figure 6: The average annual consumption of city parks (averaged for 2013-2014).

An effort was made to categorize parks based on their facilities and irrigation systems in order to estimate the consumption of similar unmetered parks. However, because the meter data does not include what exactly is covered by each meter, the consumption of similar parks in terms of their characteristics varied widely.

3 Identifying High Consumers

Based on the available consumption data, the highest water consumers were identified and can be seen in Figure 7. These above average consumers can be considered as part of three categories that characterize their high consumption:

- **Consistent High Consumers**
  - These are parks that consistently consumer large volumes of water throughout the year.
  - Examples: Stanley Park – Aquarium, Charleson Park, Stanley Park – Train West.
- **Seasonal High Consumers**
  - These are Parks that are high consumers only during one part of the year, most often summer.
  - Examples: Trout Lake, Stanley Park – Play Park, Connaught Fields.
- **Single Event High Consumers**
  - These are parks that are among the highest water consumers for 2013-2014, but only because of a single event such as a leak.
  - Example: Musqueam Park (Leak, possibly)

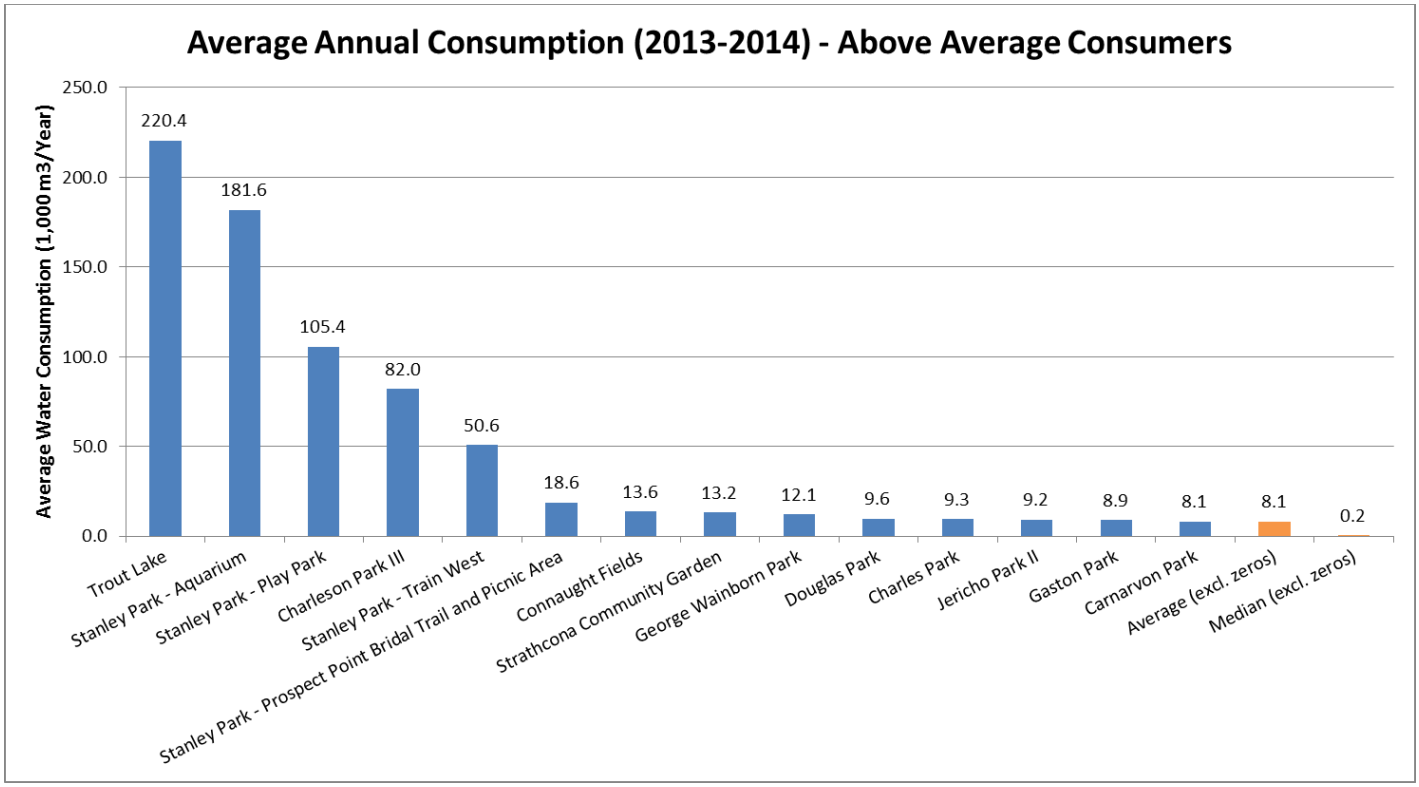

Figure 7: The 2013-2014 averaged annual water consumption for parks that are above average. Parks with meter read issues were excluded from this figure.

In order to provide a visualization of the consumption throughout the year for high consuming parks in each category, Figure 8 shows the 2013-2014 consumption of three parks representative of each category of high consumer.

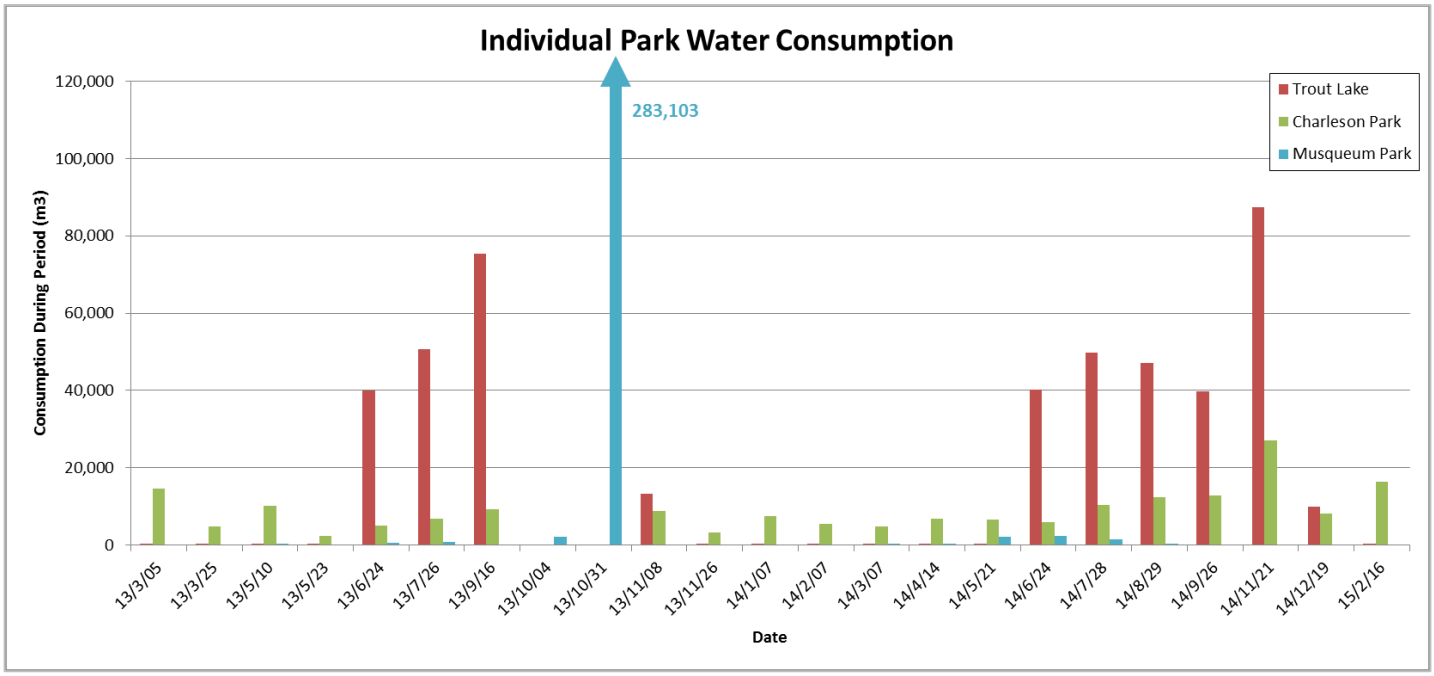

Figure 8: Selected representative parks and their consumption from 2013-present. The parks represent seasonal consumption (Trout Lake), consistent consumption throughout the year (Charleson Park), and single high consumption events, such as leaks (Musqueam Park).

3.1 A Closer Look at Selected High Consuming Parks

The following description of just a handful of the highest water consuming parks highlights the complexity of reducing potable water consumption in public spaces. Public opinion, wildlife values, and costs are just a few considerations that must be included in any conservation efforts alongside the water consumption itself. However, good data should be the basis for any water conservation strategy, and a continuation of the tremendous expansion of the water meter coverage is required. Section 4 highlights some gaps that are still present in the data and, as previously mentioned, *Report 3: High Water Consuming Parks* has a more in depth look at the highest consumers.

3.1.1 Trout Lake (John Hendry Park)

Trout Lake (in John Hendry Park) is the highest consuming park in the City of Vancouver and this is no secret. The lake is topped up with potable water over the summer months in an effort to maintain the water quality suitable for swimming, and to maintain the water level for wildlife. However it is unknown what the consequences of turning the water off would be as it has never been tried. There is some evidence however, that the addition of potable water does not affect the *E.coli* levels, however the lake is a popular swimming destination for Vancouverites, and it has been indicated that turning off the potable water to the lake might not be supported by park users. This summer (2015) however, due to low reservoir levels, Vancouver is under Stage 3 water restrictions, and the potable water addition to Trout Lake is turned off, which provides an excellent opportunity to study what the consequences are to the *E.coli* level and the impact on wildlife.

3.1.2 Stanley Park – Play Park

Stanley Park – Play Park is another good example of known high consumption. The water park is operational only during summer months, and until recently ran continuously throughout the day, consuming roughly 1,000,000 L/day during operation. The discovery of this prompted further investigation, which indicated that the park was working as designed. However, also due to the 2015 summer water restrictions the park has been turned off, and is being fitted with a user operated start button which should decrease consumption substantially when it is turned on again.

3.1.3 Musqueam Park

Musqueam Park is the best example of a single event causing a park's water consumption to drastically increase (a leak was suspected but at this point not confirmed). According to the data, this single event led to Musqueam Park being one of the largest water consumers of any park for the entire year. This highlights the benefits of ongoing monitoring of park meters in order to identify and fix leaks quickly. However work is still being done looking at some issues with the water meter data in order to verify what happened.

3.1.4 Charleson Park

Charleson Park is one of a few parks with consistent high water consumption throughout the year. This is due to the fact that potable water is used as the sole input to a small waterfall and pond in the park. The water used to run 24 hours per day, but after the installation of a water meter, and the realization that a large volume of water was being consumed by the waterfall, the water now runs only during the day. A recirculating system was considered, but proved to be too complex and costly to implement.

4 Data Gaps

There has been a significant effort to increase the coverage of water meters in City parks over the past few years. While there is still some information missing from the current water meter data (notably what they measure exactly), this section will focus on the coverage of parks. There are still a number of parks without a water meter; of the 215 total parks in the City of Vancouver, 127 do not have a water meter. However, this number is deceiving as the parks that do have a meter account for over 80% of the total park area, and many unmetered parks have no irrigation or facilities and therefore likely have very low water consumption. It is important to note however, that the water meters currently in the parks do not necessarily measure all of the water consumption for that park.

Table 10 breaks down the unmetered parks in the City by the presence of an irrigation system and facilities. The table shows that 19 unmetered parks have both an irrigation system and at least one facility. These are parks that should be prioritized for installation of new water meters in order to account for their water consumption. There are also 42 unmetered parks that do not have irrigation or any facilities, meaning that their water consumption is likely close to nothing and that installing a water meter there should not be a priority.

Table 10: Unmetered Parks – with and without facilities and irrigation systems. A list of the individual parks can be seen in the Unmetered Parks.xlsx file.

Parks	Total	Area (Ha)
Total Unmetered	127	257.9
With Irrigation	71	131.2
With Facilities	33	136.4
No Irrigation/No Facilities	42	84.7
No Irrigation/With Facilities	14	42.0
With Irrigation/No Facilities	52	36.7
With Irrigation/With Facilities	19	94.5
Automatic Irrigation/No Facilities	26	24.6
Manual Irrigation/No Facilities	26	12.1
Automatic Irrigation/With Facilities	11	62.7
Manual Irrigation/With Facilities	8	31.8

Looking at the number and facilities that are not metered may provide insight into which unmetered parks may be using more water, and should thus be prioritized for water meter installation. Table 11 shows the number of facilities that are currently unmetered. Based on the available data, the presence of a facility, especially a water park for example, increases water consumption. In addition, the data shows that larger parks tend to have higher water consumption due to their larger irrigation requirements; however this is not universal, and applied mainly to parks with playing fields, especially because some areas included in the parks list are beaches, community gardens, or other public spaces.

Table 11: Number and type of facilities that are currently unmetered.

Facility Type	#
Fieldhouses	21
Community Centres	3
Community Halls	1
Water/Spray Parks	4
Restaurants	1
Wading Pools	12
Bowling Greens	5
Swimming Pools	2
Food Concessions	4
Washrooms	32

There are a few examples of parks that should be prioritized for water meter installation. Both Locarno Park and Kitsilano Beach Park can almost be considered to be more beaches than parks and don't currently have a water meter even though they both have irrigation systems, a number of facilities (including washrooms, food concessions, etc.) and are quite large (19 Ha and 13.47 Ha, respectively). Also, Vanier

Park is also a large park with irrigation, a washroom facility, two ponds fed by potable water, but no water meter.

5 Costs

While water in Vancouver is for the most part abundant and cheap, it is not free. However, because the parks operate as part of the City, a water bill is not received or paid for water consumed by the parks. Without anyone being responsible for paying the water bill for the parks each month, it is possible that the consumption is overlooked. Based on the seasonally weighted 2013-2014 averaged water rates paid by City of Vancouver customers, the park board would have paid $1.26 Million in 2013 and $1.32 Million in 2014 for water consumed by the parks. These cost estimates do not include the costs associated with treatment in the wastewater treatment plant, which would be needed for any water that ends up in the sewage system (estimated to be 25-50% of potable water input to the parks). Considering that over 70% of the water consumed in the parks is by 10 parks, conservations measures focused on these highest users will not only have a large impact on water consumption, but may also substantially reduce the amount the city pays for parks water.

Report 3: High Water Consuming Parks

New strategies for reducing potable water use in parks and golf courses

Greenest City Scholars Program 2015
Daniel Klein
Mentor: Nick Page

August 20, 2015

Stanley Park Water Park (City of Vancouver, 2013)

Recommendations

Addressing the water use at the parks that are higher than average water consumers could significantly decrease overall consumption in the parks. The following are specific recommendations for some of the highest consuming parks.

- **Trout Lake**
  - Reducing or ending potable water addition to the lake could have a significant effect on total water consumption, but the E.coli levels, wildlife habitat, and water level must be taken into account.
- **Stanley Park – Aquarium**
  - A water audit of the Vancouver Aquarium would help identify conservation opportunities.
- **Stanley Park – Play Park**
  - Look into the possibility of installing location specific activation buttons. Instead of the button activating the whole park, installing buttons that activate only the area where the button was pushed, avoiding water use in areas that are not used.
- **Stanley Park**
  - The Train West and Prospect Point Trail and Picnic Area are high water consumers, and while there is a good idea of where the water flows, an audit of Stanley park potable water could be very helpful in understanding how water is used, and if there are any opportunities for conservation.
- **Water Features**
  - A number of high consuming parks (including George Wainborn Park and Charles Park) have potable water fed water features such as ponds or waterfalls. A closer examination of these features may help in determining if water conservation measures are possible.
- **Charleson Park**
  - Potable water is the only source for a waterfall and pond at Charleson Park. Currently the water is on all year, and peaks during summer months. This is something that could be looked at more closely, and eliminating the water use during winter for example, would significantly reduce water use.
- **Irrigation**
  - Irrigation contributes significantly to water consumption in parks, and accounts for a large portion of the use at Connaught Fields, Douglas Park, Jericho Beach Park, Gaston Park, and Carnarvon Park. These parks tend to have a number of sand based sports fields which require more irrigation than soil based fields. A closer look at the irrigation of sports fields in the parks might help identify unusual water use, and conservation opportunities. The development of a baseline for average irrigation water use by field and field type could help identify parks that are using more than average.
- **Meter Issues**
  - Because non-revenue generating park's water consumption is paid for through general revenue rather than billed to the departments, issues in the data that may go unnoticed. An ongoing monitoring of parks water data could help avoid these problems.

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1 Introduction

Total water consumption in City parks is dominated by a handful of above average water consumers. In an effort to reduce potable water consumption in the parks, the focus of this report it to characterize the water use at each of those parks, essentially to determine the reason for their high consumption. The parks chosen for examination can be seen in Figure 9. There were a handful of parks that were recorded as being above average, but due to some issues with their data, were excluded from Figure 9; they are discussed in Section 3.

A look at the City's water data can be seen in *Report 1: Park Water Data* more in depth examination of water consumption in all City parks can be found in *Report 2: Parks Water Consumption and Data Gaps*.

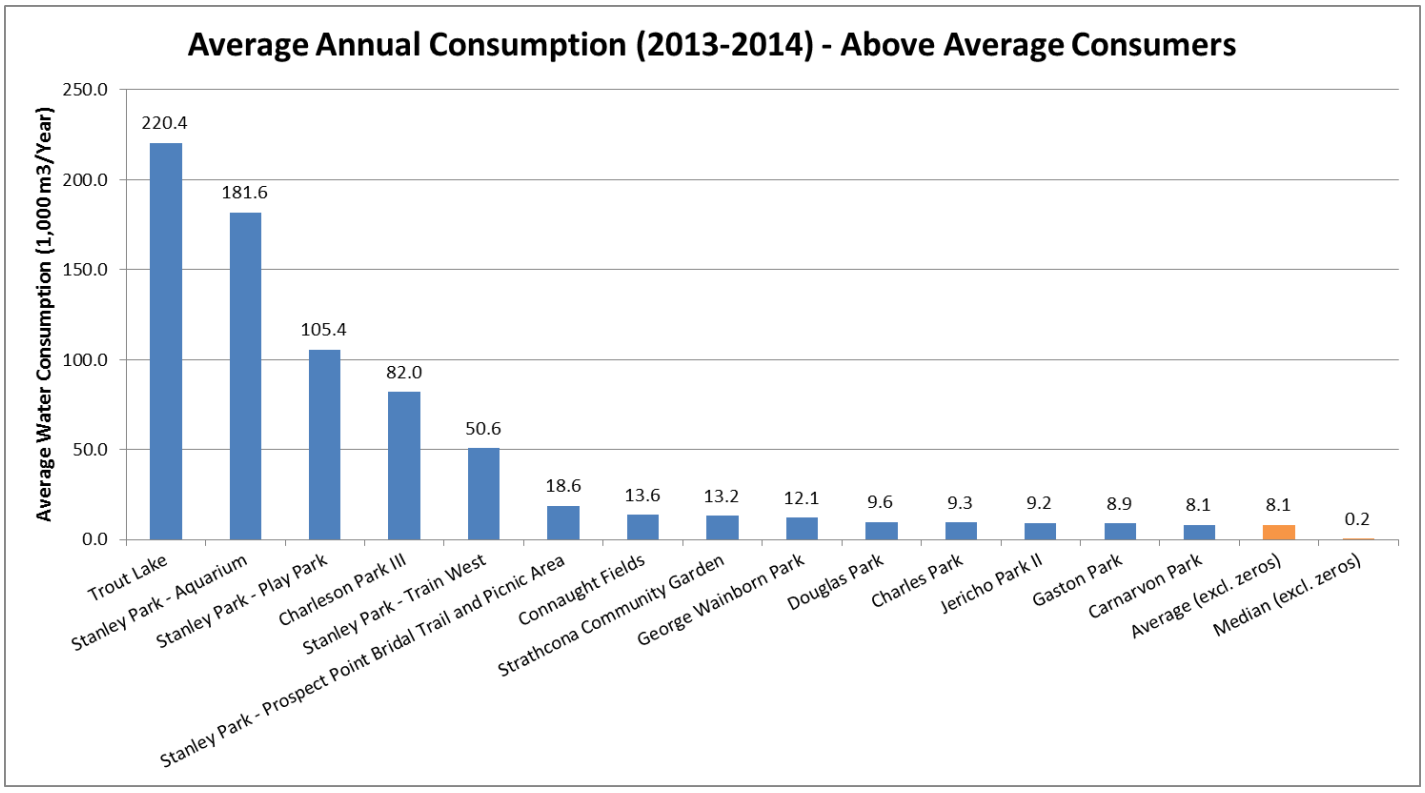

Figure 9: The 2013-2014 averaged annual water consumption for parks that are above average (Excluding meter data issues).

2 Above Average Water Consuming Parks

The following sections take a closer look at the consumption of each of the above average parks. It is important to note that it is somewhat difficult to determine exactly what the water meter measures, and many of the park water systems are quite complex, leading to greater difficulty in determining where the water goes. A chart of the 2013-2014 averaged daily water consumption for each park is presented, along with a description of how the water is consumed, and any other considerations.

The November Anomaly

The park meter data was slightly modified for about half of the parks because the November 8th, 2013 meter reading recorded an anomalous reading. Essentially, for a reason that is unknown at this point, some of the park meters recorded a very high water consumption reading for the same period. The author chose to remove those reading from the data and charts presented in this report. The reason for this was that in many cases, water consumption in the park is seasonal and not turned on during the winter (seen in the data as the adjacent readings were zero). Furthermore, the fact that it was consistent across a number of parks indicates that it was not simply a case of someone turning on the water by mistake or a leak.

2.1 Trout Lake (John Hendry Park)

Trout Lake (in John Hendry Park) is the highest average water consuming park in the city. There are two water meters in Trout Lake, but only one is above average due to the large volumes of potable water which are added to the lake during summer months. The water is added to maintain the water level, which decreases in the summer primarily due to evaporation. In addition, the lake provides important habitat for wildlife, which may be affected by the water level. The author did not come across any empirical evidence however, to support the theory that without the addition of potable water, the level would decrease to a level that was unacceptable. The lake also sits primarily on peat which means that there is little water loss through infiltration.

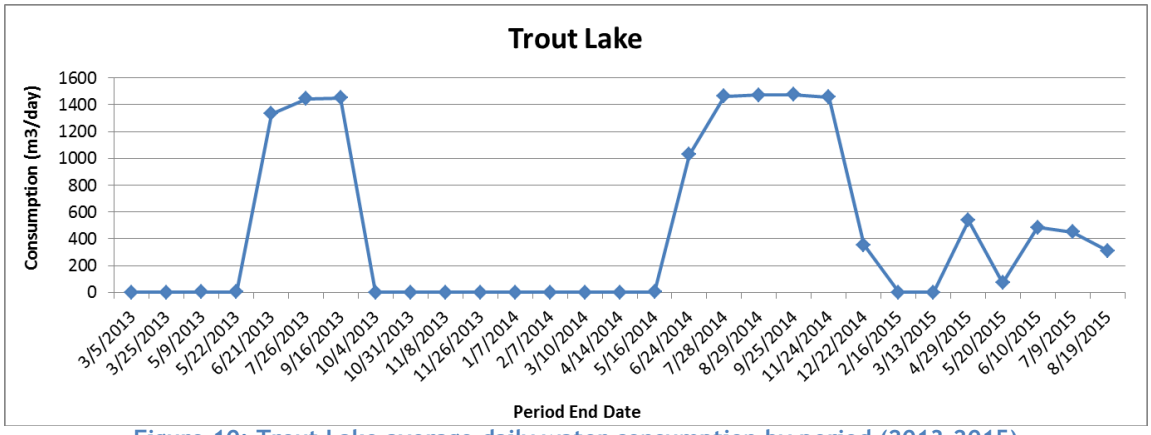

Figure 10: Trout Lake average daily water consumption by period (2013-2015).

Trout Lake is used for swimming in the summer, which is closed at times by high *E.coli* levels (tested weekly by Metro Vancouver and published online by Vancouver Coastal Health. The historical practice of adding potable water to the lake was thought to keep the pathogen levels at an acceptable for swimming based on the Vancouver Coastal Health Guidelines (< 200 *E.coli*/100ml). Again, there is no empirical evidence to support this theory, and a UBC student report found that the potable water had no effect on *E.coli* levels in the lake. Public opinion has in some cases also supported take top-up. There has been at least one instance where the potable water was turned off, and the Park Board received numerous and consistent requests from the public to turn the water back on, mostly because the public opinion was that without the water, the lake would be closed for swimming.

This summer (2015), Vancouver is experiencing a particularly dry season, and is currently under Stage 3 water restrictions which have forced the potable water addition to Trout Lake to be turned off. This makes it an ideal summer to examine more closely the effects of reducing or ending the potable water addition to Trout Lake. While the *E.coli* levels are measured weekly, the water level in the lake is not monitored, and the effect on wildlife populations must be observed. Figure 3 shows the *E.coli* level in comparison to the potable water added to Trout Lake for 2011-2015. The potable water added to the lake and the *E.coli* levels are actually negatively correlated, adding to the evidence that the addition of potable water does not significantly affect the pathogen levels in the lake. However the effects on lake level and wildlife are also vitally important, and must be considered before any decisions about turning off the water are made. This year, 2015, the *E.coli* levels are still following the typical pattern seen in previous years despite the significant decrease in water added to the lake (reaching a maximum, up to this point, of 161 *E.coli*/100ml).

Reducing or ending the potable water addition to Trout Lake could significantly decrease water consumption in the parks overall, but there are more considerations than just water consumption and *E.coli* that must be taken into account such as wildlife habitat and the water level.

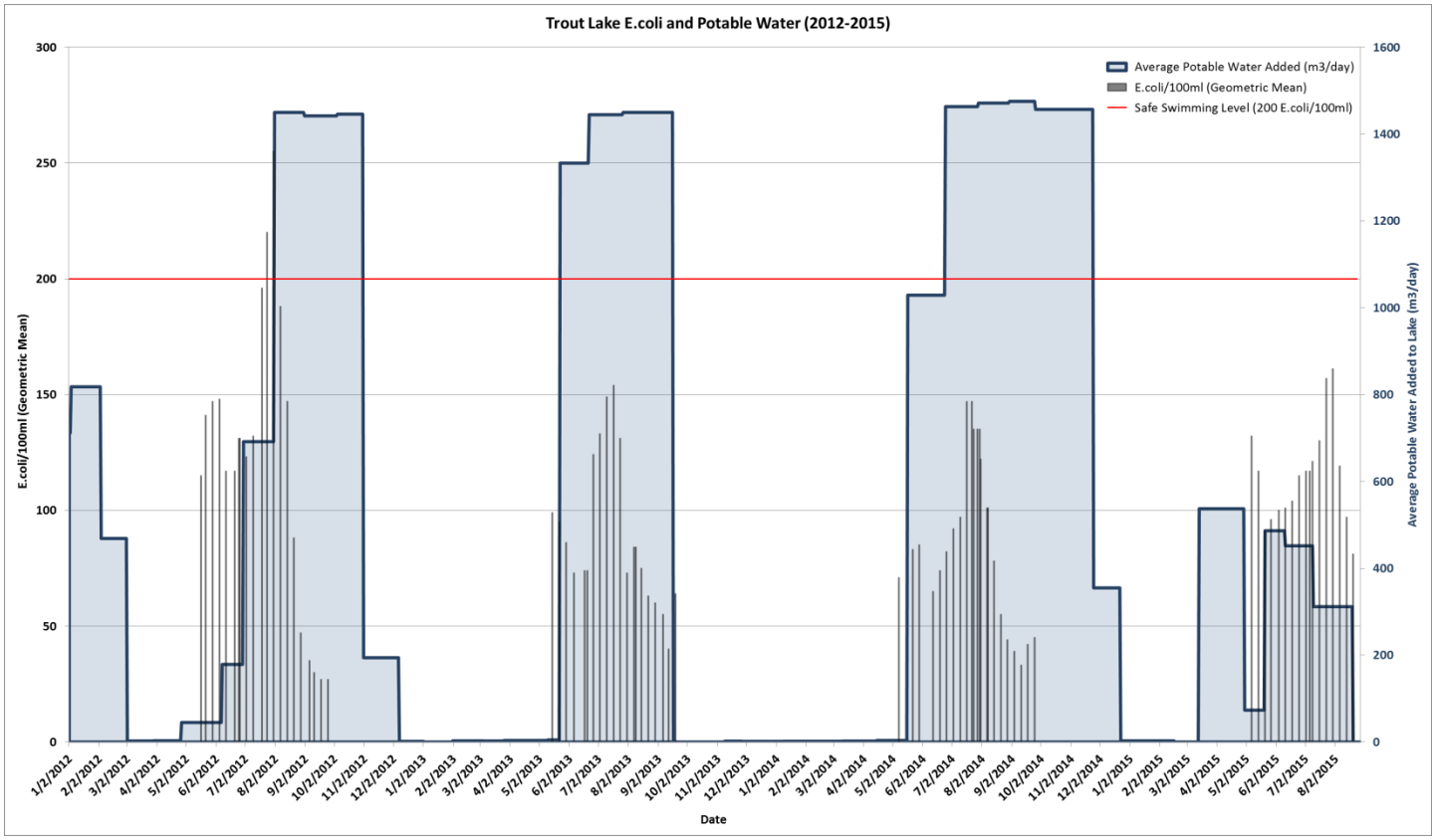

Figure 11: *E.coli* levels and daily average potable water added to Trout Lake (2012-2015).

2.2 Stanley Park – Aquarium

The Stanley Park Aquarium is a unique facility that requires significant water resources for its operations and guest services. The Aquarium has both fresh and salt water species, so only the fresh water tanks use potable water. An educated guess (by Guy Pottinger, Supervisor Stanley, Queen Elizabeth, Sunset & Downtown Parks & Beaches Maintenance) is that the salt water outflow from the Aquarium is near Lumberman's Arch. The source of the freshwater for the salmon stream is located within the Aquarium ground has yet to be verified. A better understanding of how the Aquarium uses water would help determine if conservation was possible.

The Aquarium is billed directly by the City, but it is not clear if all of the meters on site are included and billed separately, or if only one meter is billed. The bill seen by the author was for a meter that was not on the park meter route.

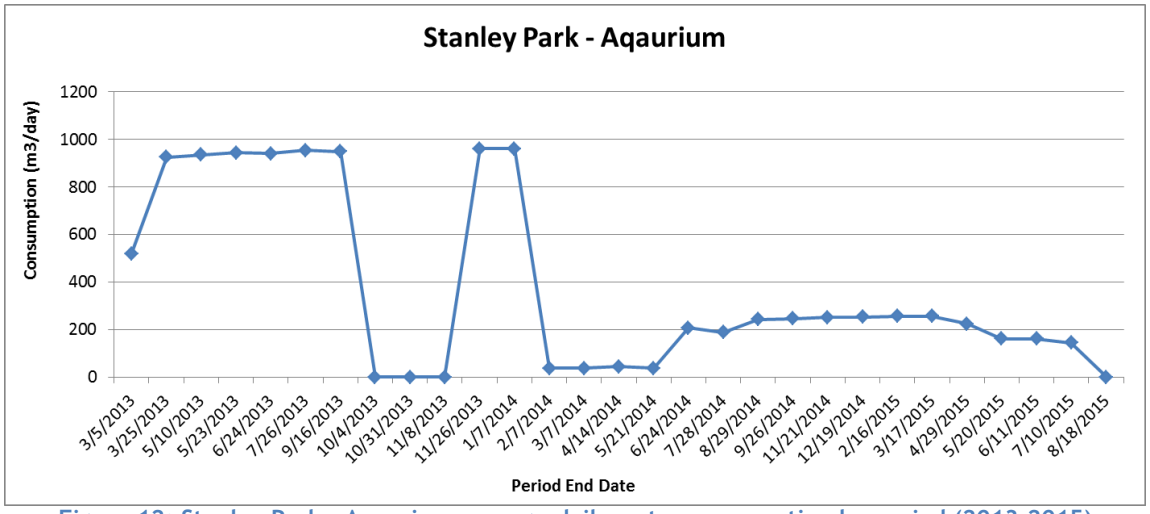

Figure 12: Stanley Park – Aquarium average daily water consumption by period (2013-2015).

2.3 Stanley Park – Play Park

Stanley Park water park (Play Park) is located near Lumberman's Arch, and until recently ran continuously during the summer daytime hours, consuming roughly 1,000 m^3/day (1,000,000 L/day) of water. An investigation into this high water consumption found that the park was functioning as designed.

Things have changed recently however, and due to the Stage 3 water restrictions (Summer 2015), 3 activation buttons were installed which activate the water in the park for ~5 minutes from 10am to 8pm. While this is an important improvement, there is still some room for better water efficiency. Observation of the park showed that the button was being pushed constantly during busy hours, and because it activated the whole water park, did not correspond directly with the areas being use (if children were only playing in one end of the park, the button still turned on the water for all of the areas). That being said, the activation buttons will likely translate into water savings due to the fact that the park will not be consuming water at times when no one is using it (for example during days or times when the weather is not suitable for the water park).

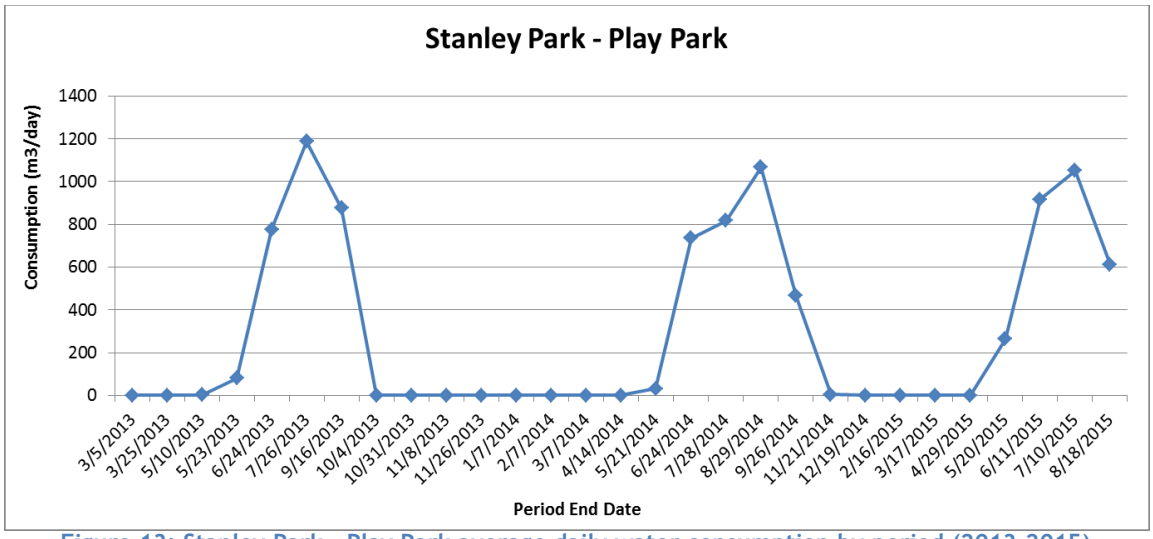

Figure 13: Stanley Park - Play Park average daily water consumption by period (2013-2015).

2.4 Charleson Park

Potable water is the only supply to a small waterfall and pond in Charleson Park. Initially, the water was supplied for 24 hours a day, but after the installation of the water meter, and the realization that the water consumption was very high, the water is not only supplied during the day. A recirculating system was looked into, but considered to be too complex and costly, so it remains a "once through" system. Charleson Park has 4 water meters, with this one presented here in Figure 14 being the supply to the waterfall.

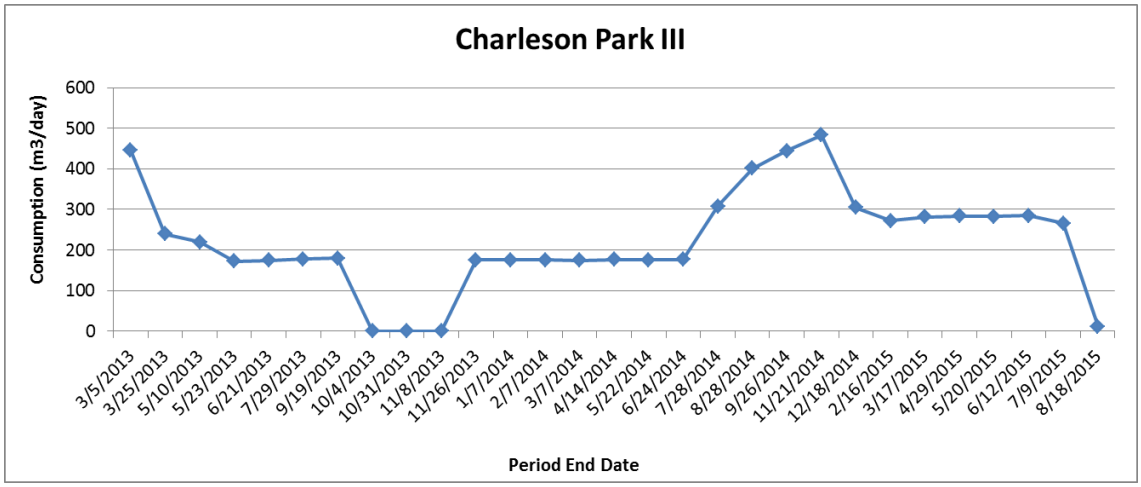

Figure 14: Charleson Park average daily water consumption by period (2013-2015).

2.5 Stanley Park – Train West

The Stanley Park train has two water meters, the west meter records significant water consumption throughout the year, and the East meter seems to be on a dead line and records zeros. According to a number of sources, the potable water fills the pond and runs the water wheel, which is not recirculating. This water is then piped underground to Beaver Lake. The Train West meter may also feed a water feature which is recirculated by pump, but evaporation and leaks mean that is must be constantly

topped up. There is no confirmation as to whether or not that top up water is from the Train West meter.

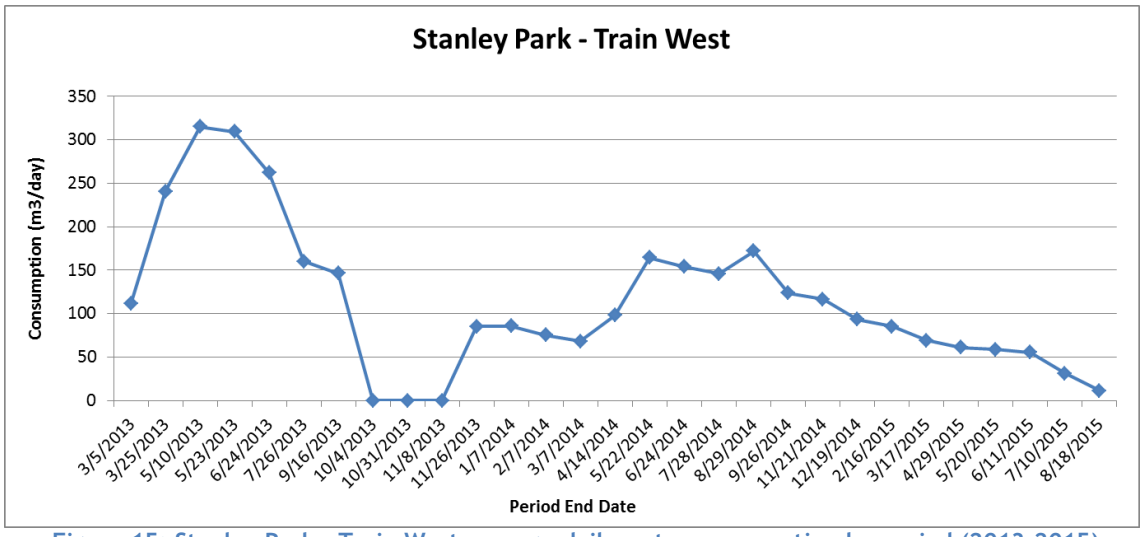

Figure 15: Stanley Park – Train West average daily water consumption by period (2013-2015).

2.6 Stanley Park – Prospect Point Trail and Picnic Area

The Stanley Park Prospect Point Bridal Trail and Picnic Area water meter does not in fact measure the consumption at the picnic area. The water accounted for in this meter is the source for Beaver Lake, which runs from this meter down to the lake (about 0.8 km). This is the primary feed for Beaver Lake, but not the only source of water (the overflow from Train West also feeds into Beaver Lake, for example). Interestingly, this meter is labeled as "Beaver Lake" in the AssetPlanner database, which makes things more clear. The water for this site was turned off in the winter of 2014, and not turned on in the spring of 2015.

The picnic area adjacent to the water meter has washrooms, as well as a caretaker residence, but it is understood that this water consumption is not captured by this meter.

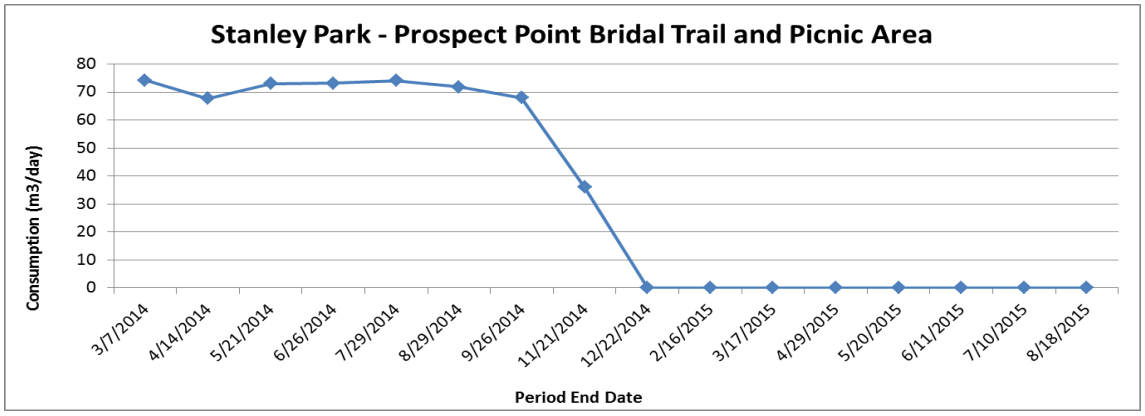

Figure 16: Stanley Park – Prospect Point Bridal Trail and Picnic Area average daily water consumption by period (2013-2015).

2.7 Connaught Fields

Connaught Park is a very large park with three sand based sports fields that require consistent summer irrigation (even during Stage 3 Restrictions). These fields are automatically irrigated roughly twice a week, and due to the size of the irrigated area, water consumption is above average. The name of the meter (Connaught Fields) makes it seem as if the water meter likely measures the irrigation of the fields, but the park also has a water park, clubhouse, and ice rink (which may be covered by the Connaught Park meter discussed in Section 3.1).

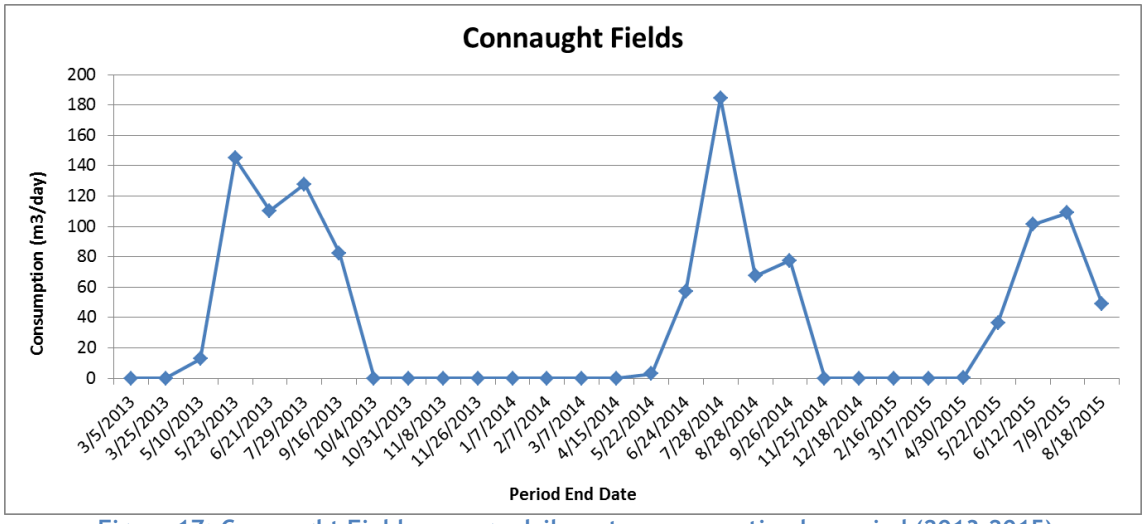

Figure 17: Connaught Fields average daily water consumption by period (2013-2015).

2.8 Strathcona Community Garden

The Strathcona Community Garden is very large (1.35 Ha), and includes a greenhouse, pavilion, orchard, a seasonal pond, small pool, herb garden, and 200 garden plots. The large size of the garden, and therefore its large number of plants and trees that require water likely accounts for much of the water consumption at the site. The data shows that water consumption is highest during summer months, which is when most of the planting is done, and peaks during September, but it is not clear why that is.

Unfortunately, the water meter data in Tempest is confusing. There are two meters for the same account, and the meter that has been working for 2013-2014 has one digit too many, which is dropped for each reading – with both the real and modified readings left in the table. That being said, it seems as if the data, after some modification, is correct.

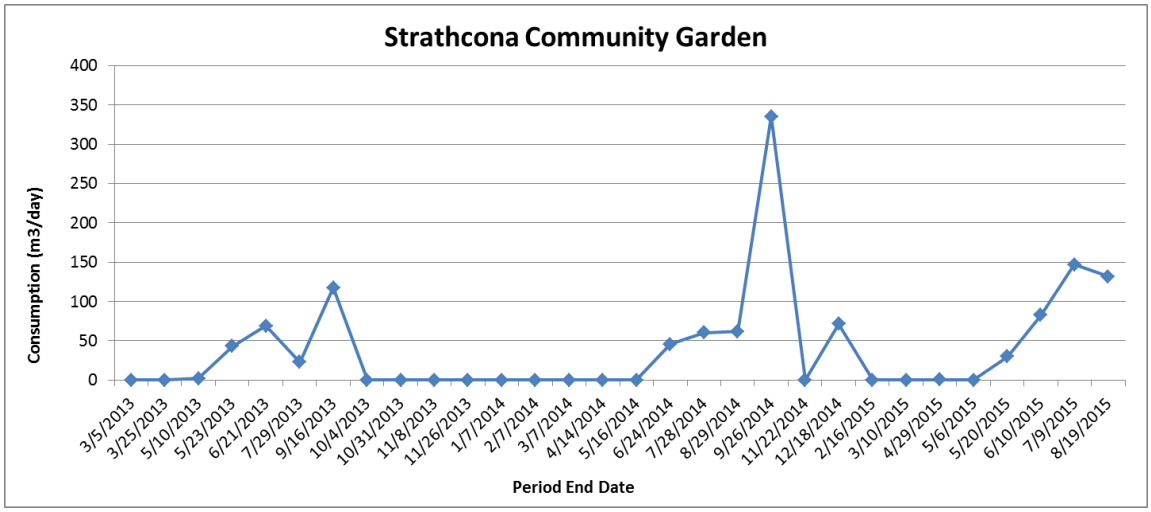

Figure 18: Strathcona Community Garden average daily water consumption (2013-2015).

2.9 George Wainborn Park

George Wainborn Park has a recirculating water feature that, due to evaporation, especially during summer months, must be topped up by potable water. The park also has an automated irrigation system and two drinking fountains which contribute to water consumption.

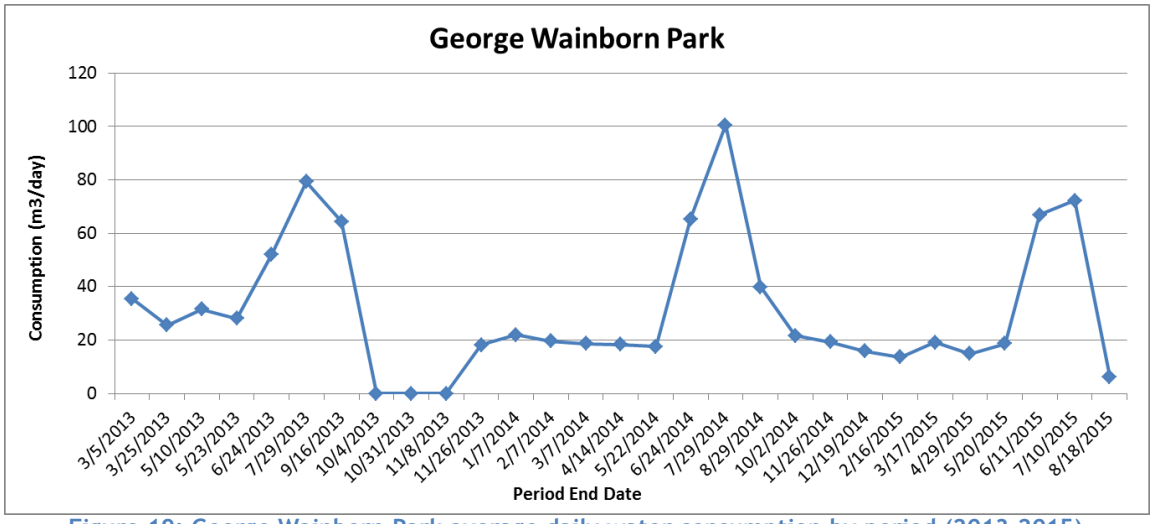

Figure 19: George Wainborn Park average daily water consumption by period (2013-2015).

2.10 Douglas Park

Douglas Park is a large park with a number of sand based sports fields. Only the West side of the park is irrigated (automatically), along with a number of orchard trees on the north end. Even with only half of the park being irrigated, the area is still quite large, accounting for the high water consumption, and because the fields are sand based they are still being watered during Stage 3 restrictions. The park also has a water fountain and a wading pool which is filled up every day during the summer, and drained in the evening, both of which also contribute to the high water consumption.

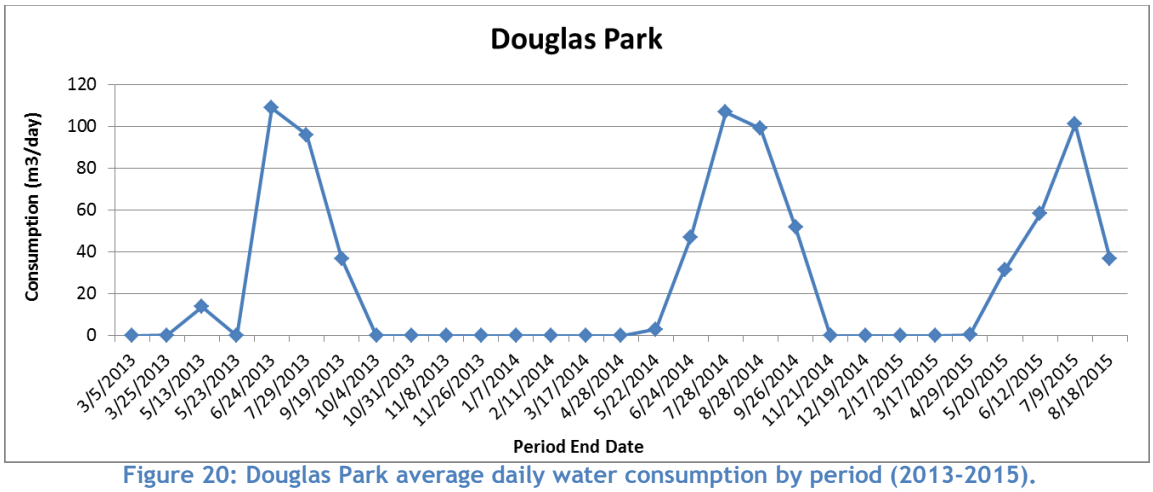

Figure 20: Douglas Park average daily water consumption by period (2013-2015).

2.11 Charles Park

Charles Park has a small pond which is fed by potable water. While the park has no facilities or playing fields, it does have a manual irrigation system, which would also contribute to the water consumption. The seasonal consumption seen in the data indicates that the pond is likely topped up during summer months in order to maintain the water level.

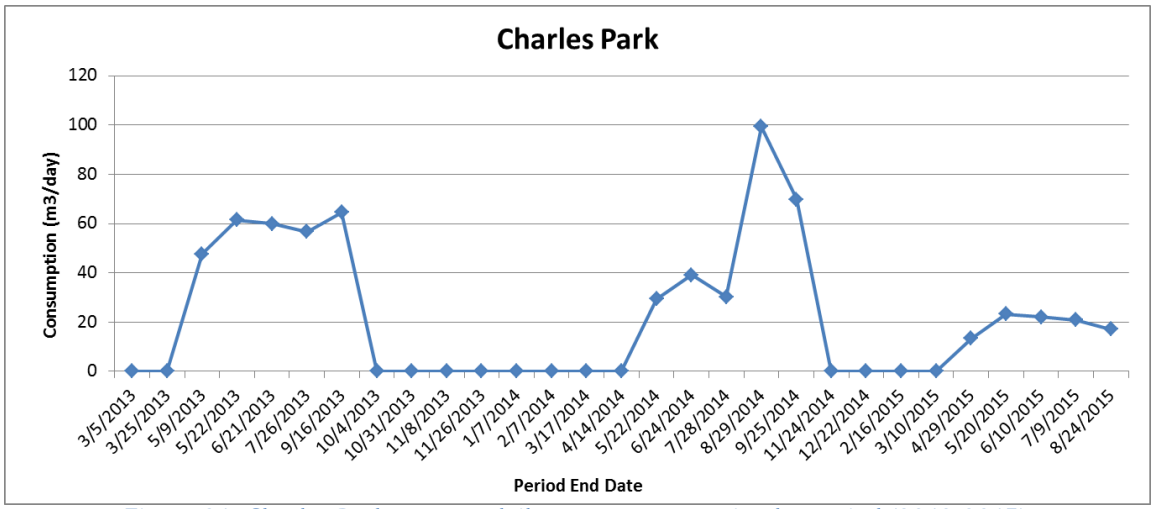

Figure 21: Charles Park average daily water consumption by period (2013-2015).

2.12 Jericho (Beach) Park

Jericho Park is very large and includes a number of facilities. The park includes an artificial sports field, a number of soil based sports fields, a sand based sports field, and a baseball diamond, all of which are irrigated automatically. The sand based field is irrigated even during the Stage 3 water restrictions. In addition to the large volume of water needed for irrigation, the Vancouver Folk Music Festival is held annually at the park during the summer (mid-July), and is also a large consumer of water. It is not exactly clear if the water meter includes this consumption, but if it does, the Festival would contribute significantly to the water use. The park also has a caretaker on site.

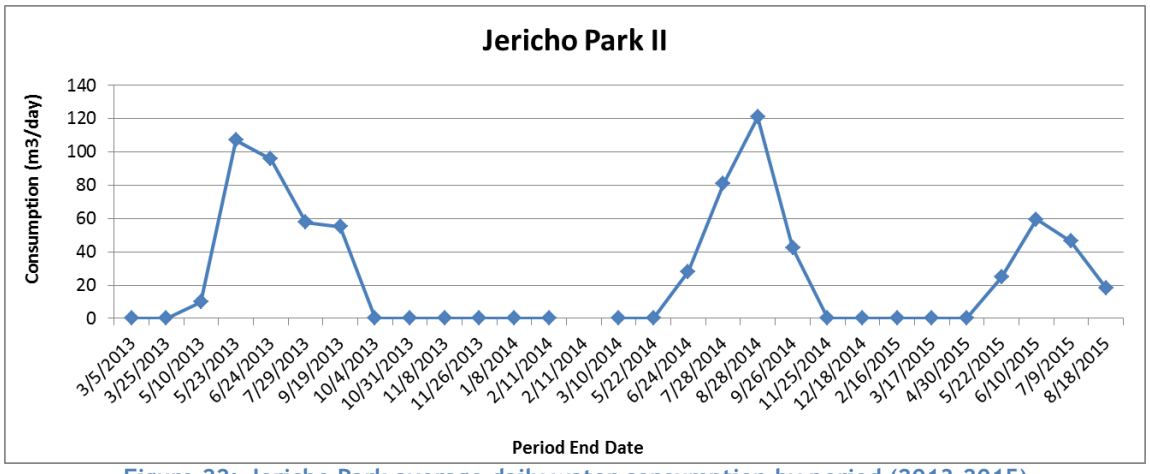

Figure 22: Jericho Park average daily water consumption by period (2013-2015).

2.13 Gaston Park

Gaston Park has an automated irrigation system which is used to water a soccer field and baseball diamond. The park also has a number of drinking fountains, but no facilities.

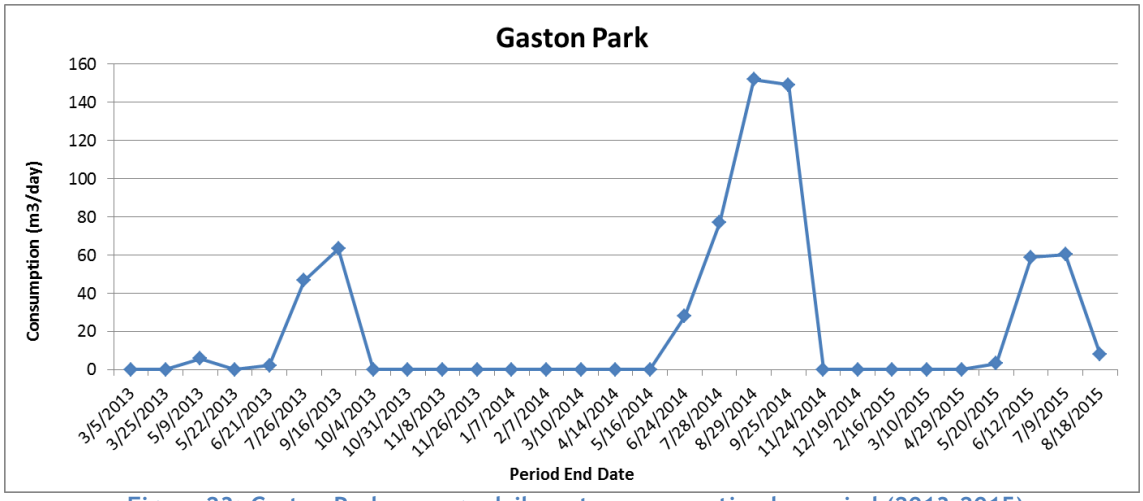

Figure 23: Gaston Park average daily water consumption by period (2013-2015).

2.14 Carnarvon Park

Carnarvon Park has a number of sports fields (3 baseball/softball diamonds, 1 soccer field, and 1 football field) which are irrigated by an automated system. The irrigation system is likely the greatest contributor to the water consumption in the park, but there is also a fieldhouse and washroom on the site which also add to the water use.

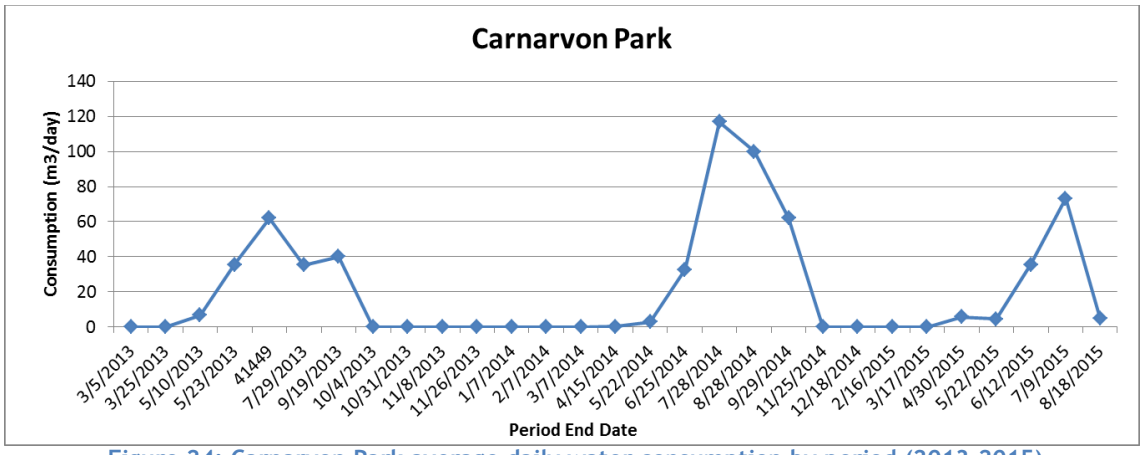

Figure 24: Carnarvon Park average daily water consumption by period (2013-2015).

3 Above Average Water Consuming Parks – Meter Issues

The following is an explanation of a number of parks that were initially thought to be above average consumers based on their Tempest data. However, after a closer examination of their water consumption, these water meters seem to have had problems with incorrect readings, or some other confusion (possible maintenance related) which has led them to have a high recorded water consumption even though that may not necessarily be the case. Unfortunately, an issue of an incorrect meter reading was also discovered for the Musqueam Park meter, which was suspected of having to have a very large leak. This means that while some of the meters below are known to have meter issues, some may in fact have been leaks. An explanation of the issue and the meter is detailed for each park below.

3.1 Connaught Park

The Connaught Park meter has recorded modest water consumption during summer months (~0 - 75 m^3/day), aside from a single event in November 2014, when a dramatic single period increase in consumption was recorded. Based on the meter numbers recorded in Tempest, the meter reading for September 26, 2014 was higher (16043) than the reading for November 25, 2014 (15950), and the consumption was recorded in the system as 1,665 Units/day (4,715 m^3/day) . This can either represent a leak, or possibly that maintenance was conducted on the meter which changed the counter, causing the issue.

As mentioned in Section 2.7 that discussed the Connaught Fields meter, the park has a water park, which may be covered by this meter, but unless there was a leak, would not account for the large consumption incident.

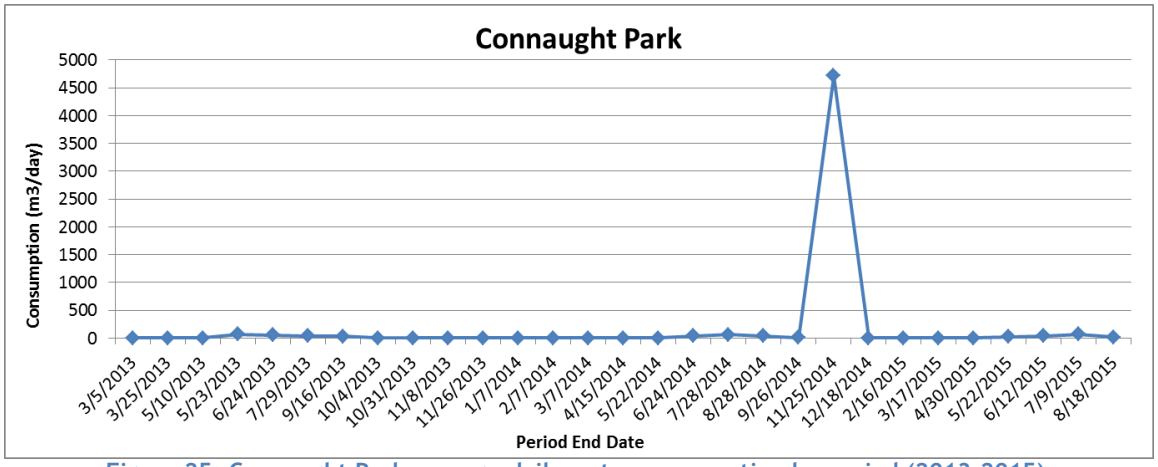

Figure 25: Connaught Park average daily water consumption by period (2013-2015).

3.2 Musqueam Park

Musqueam Park is not included in Section 2 because of various particularities with the meter readings and consumption. However, discussions with staff, the park appeared to have a substantial leak in 2013. Average water consumption at Musqueam Park is very small, however should the leak recorded by the meter be accurate, it would be one of the biggest water consuming parks in 2013-2014. The meter reading recorded water consumption that was over 20,000m^3/day (almost 300,000 m^3 total). However it is important to note that during a high consumption even such as a leak, the water meters may not accurately record the water consumption (they are designed to be unable to over record consumption, but if there is an issue or leak, they may record a lower water consumption than in reality). In this case, the meter counter read 10526 on November 12, 2013, and 10506 on November 26, 2013 (a lower value), and a consumption of 7,141 units/day (20,222 m^3/day) over that 14 day period was recorded. Furthermore, the leak (as seen by the data) happened during November of 2013, which is consistent with the unknown anomalies seen in other parks.

Overall, it is unclear at this point whether this is an incorrect meter read (as indicated by the meter counter and the November anomaly) or a leak that caused the meter to run incorrectly (as indicated by discussions with staff).

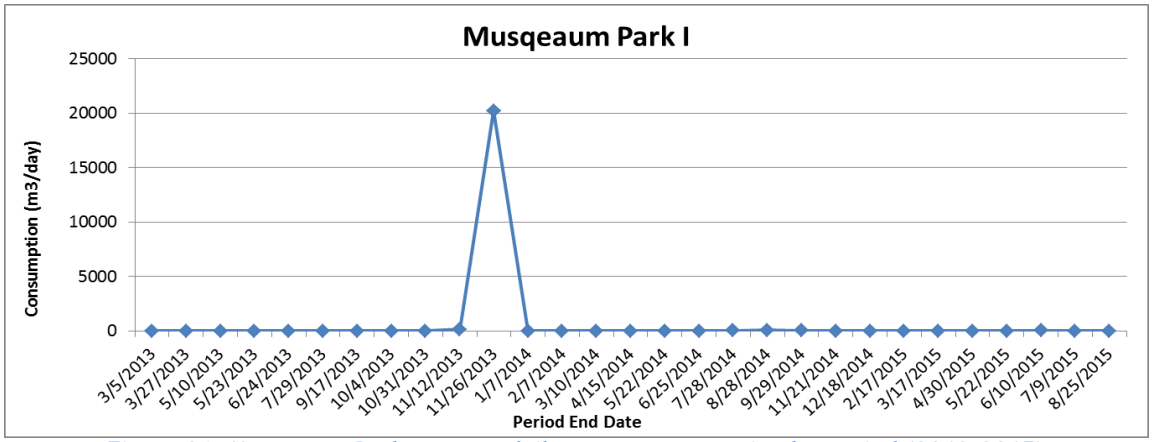

Figure 26: Musqueam Park average daily water consumption by period (2013-2015).

3.3 Stanley Park – Rowing Club

The Rowing Club North water meter is not working properly which explains the two very large consumption periods. Based on an examination by a tradesman, the meter does not seem to feed the Rowing Club building, and does not seem to be measuring anything at the moment. Furthermore, the high values seen in Figure 27 are due to the meter counter jumping from 11 to 12, then backwards to 11. This has occurred twice during 2013-2014 and the consumption recorded in Tempest is 9999 units independent of the period length, which puts the meter well above average in terms of consumption. One of the occurrences is in November 2013, which is consistent with the November anomaly seen at other parks, but the repetition of the incident in the data motivated its exclusion from the high parks list. Apparently this problem may be due to a faulty PRV (Pressure Reducing Valve?), and a crew has been sent to test the line to see if that is the case. It was also reported that the meter is in the process of being changed.

Considering that this meter does not seem to measure consumption at the Rowing Club itself, the water use at the club is not included. Unfortunately, it was not clear what water consumption is captured by this meter, or even where it might be used.

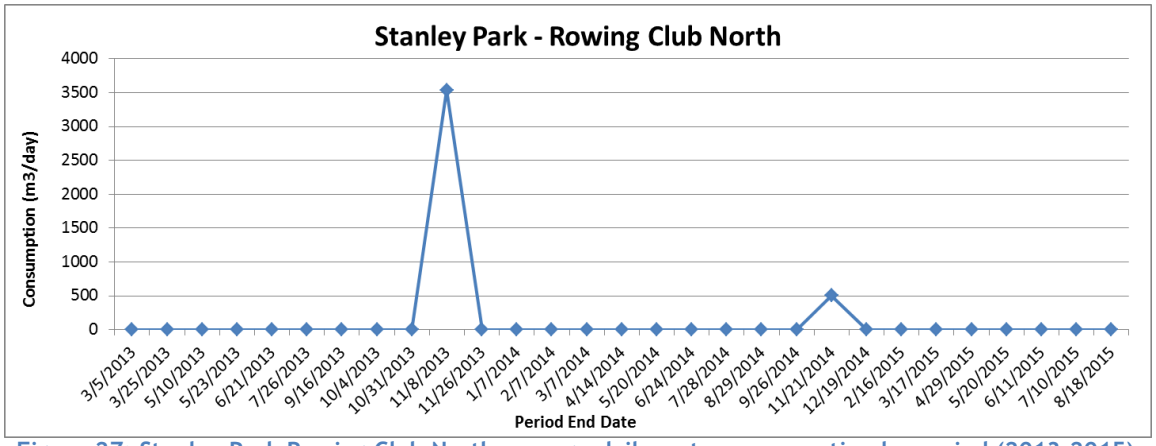

Figure 27: Stanley Park Rowing Club North average daily water consumption by period (2013-2015).

3.4 Sunrise Community Centre

The Sunrise Community Centre is included on the parks meter read route (7500), which is strange because other community centre meters are not on that route. Furthermore, there are two water meters under the Sunrise Community Centre account number, and it is unclear how they differ and what they measure.

The normal consumption from 2013-2014 for the Sunrise meter was between 0 and 25 m^3/day, with peaks during summer months. For a single period in July 2013 the consumption jumped up to 272 Units/day (770 m^3/day). Similar to the other cases in this section, the water meter counter seems to be the issue: for June 21, 2013 the meter counter read 548, but for July 26, 2013 it decreased to 63, which then was counted as a consumption of 272 Units/day (770 m^3/day) for that period. According to the meter shop the meter was tested during this period and the counter changed, but was subsequently reprogrammed to the appropriate number of digits in July (2015), but the data does not show that the counter was reset.

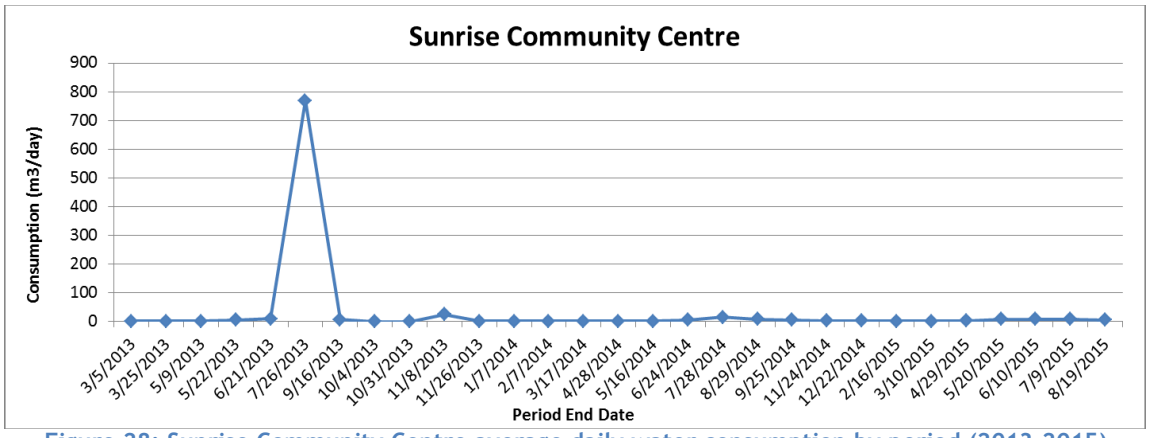

Figure 28: Sunrise Community Centre average daily water consumption by period (2013-2015).

3.5 2600 N Grandview Hwy.

The high consumption associated with this meter is likely a meter reading error. The normal water consumption at this site is between 0 and 1.4 m^3/day. The high value recorded in March 2013 seems consistent with the meter being initially calibrated, or reset; the March 5th 2013 read was 4004, while the March 26, 2013 reading was 401, but the consumption was measured as 305 Units/day (866 m^3/day).

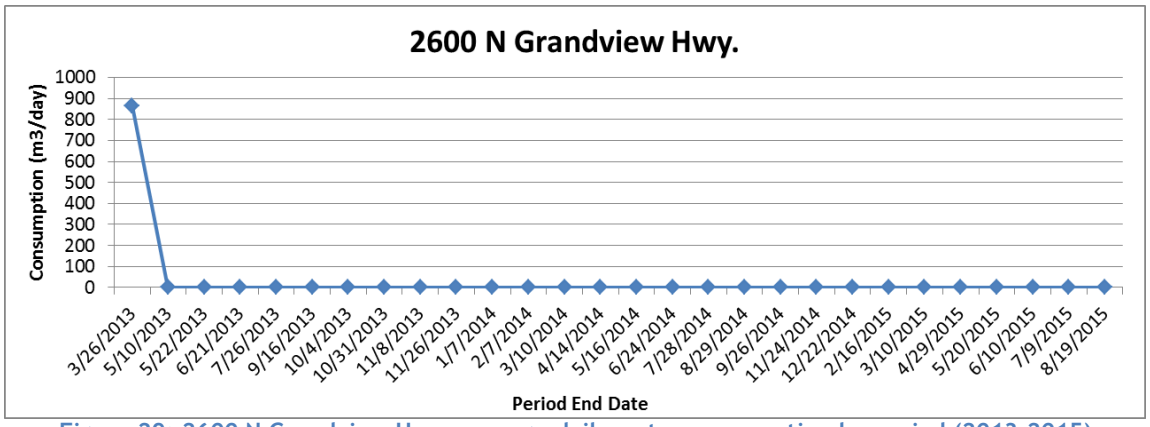

Figure 29: 2600 N Grandview Hwy. average daily water consumption by period (2013-2015).

4 Conclusion

Based on the research conducted for this report, and in light of the previous reports, there are a few actions that should be considered as part of decreasing water use in City parks. First, water efficiency measures should be focussed on the high consuming parks, which account for the majority of the water consumption in the parks. Second, ongoing monitoring of the parks meter data would facilitate better management of the water by catching meter misreads and leaks in a timely fashion.