Date: April 21, 2022

To: Mayne Island Housing Society

From: MSR Solutions

Subject: Mayne Island Housing Society Water Management Plan

1. Introduction

375 Village Bay Road is a proposed affordable housing development on Mayne Island, BC by the Mayne Island Housing Society (MIHS). The proposed development includes five 1-bedroom units, four 2-bedroom units and one 3-bedroom unit. MIHS has retained MSR Solutions Inc. (MSR) to investigate water demand requirements as well as a preliminary investigation into stormwater management for the property. There is currently no plan to utilize graywater. This report has been prepared in support of an application for Rezoning made to Islands Trust.

2. Design Basis

2.1. Water Demand

Residential water demand is attributed to the following general categories:

- **Indoor Demand** – includes all regular indoor usage of water within a residence, including from sinks, toilets, showers, wash machines, dishwashers, indoor plants, etc.
- **Outdoor Demand** – includes regular outdoor usage such as irrigation and use of outdoor hoses (e.g. for washing cars).
- **Leakage** – losses from leakage tend to increase as systems age and with the size of the system. For a newly installed small system such as proposed for MIHS, leakage will be minimal.

2.2. Water Sources

Indoor water demands will be supplied by well water. The recently drilled well on site had a 72-hour variable rate pump test performed in October of 2020[1]. The project well WID 43943 was subsequently pump tested by Red Williams Well Drilling & Pump Installations Ltd., at a constant rate of 11.84 L/min (3.13 USgpm) for just over 72 hours from October 3 to October 6, 2020. The average drawdown of the cumulative pumping was equal to 4.52% of the available head in the well. The Hydrogeologist has indicated that the well has a sustainable yield of a minimum of 11.84 L/min (3.13 USgpm).

[1] Hy-Geo Consulting *Report on Assessment of Pumping Test on WID 43943 for Proposed Affordable Rental Housing Project, Mayne Island* (2020)

A water licence application (Tracking number 100351846) was submitted in 2021 for 7.36 m^3/day and a total annual quantity of 2686 m^3/year to be diverted. The groundwater licence will require that the water volumes diverted be measured and recorded.

To ensure the safety of the water supply, all requirements of the Drinking Water Protection Act and Drinking Water Protection regulation should be followed in regards to wellhead protection. Wellhead protection will be thoroughly assessed through the regulatory approvals through Island Health that will be required for development.

The Hy-Geo consulting report noted that "pumping water levels would not be drawn below sea level precluding the possibility of sea water intrusion" at any time. However, management practices for the prevention of saltwater intrusion shall be adhered to[2]. Strategies will include well level monitoring, water conservation, detection and mitigation of leakage, setting the timing of the well pump to provide "Well sipping", and the provision of adequate storage. The well was monitored from September 2021 to February 2022 and the results were consistent with the original Hy-Geo report from 2020[3].

Water demand at the development will vary depending on the occupancy of the 10 units. To balance the flow from the well against varying daily demand over a 12-16 hour period, storage and replenishment will be implemented.

2.3. Population

Using Table II- 9 from the BC Ministry of Health Sewerage System Standard Practice Manual (SPM) Version 3, a different population equivalent can be assigned to each unit type. These values fit closely to MSRs experience. The population data can be seen in Table 1 below. In the preliminary concept design, the development will have five 1-bedroom units, four 2-bedroom units and one 3-bedroom unit.

Table 1: Occupancy Equivalents

Units	SPM Occupancy per Unit	Total Occupancy
1 Bedroom (x5)	2	10
2 Bedrooms (x4)	3	12
3 Bedrooms (x1)	3.75	3.75
Total		25.75

[2] Province of British Columbia *Best Practices for Prevention of Saltwater Intrusion* (2016)

[3] Hy-Geo Consulting Groundwater Level Monitoring, Well WID 43943 (WTN 122538) at Village Bay Road, Mayne Island (2022)

MIHS estimates occupancy of 25.75 persons. As such, the water management plan will account for a minimum of 25 and maximum of 30 occupants.

2.4. Indoor Water Demand for Anticipated Use

Using the maximum and minimum population buildouts and projected flows, the total water demand can be calculated. The BC Design Guidelines for Rural Residential Community Water Systems (RRCW) uses an Average Daily Demand (ADD) of 230 L/person/day. These guidelines are generally over-estimations of actual use in small systems built with modern low-flow fixtures. For a user based average flow we can use the Capital Regional Districts (CRD) data of 232 L/p/d along with an estimate of indoor usage percentage (72%) to come to an average of 167 L/p/d for indoor use. Based on a previous assessment by Hy-Geo (2020), the potential residential water demand at the proposed facility is 7,360 L/day, or equivalent to a continuous pumping rate of 5.11 L/min. All three values were used as a comparison to show a range of potential water demands. Results can be seen in Table 2.

Table 2: Average Daily Demand using RRCW, CRD, and Hy-Geo Consulting flows

	RRCW		CRD		Hy-Geo Consulting	
Population (persons)	25	30	25	30	25	30
Flow (L/person/day)	230	230	167	167	245	245
Total (L/day)	5,750	6,900	4,175	5,010	6,125	7,360

The total demand in the highest case scenario (30 people @ 245 L/p/d) equals the maximum daily flow specified in the water license application. This represents a maximum value of indoor usage for the development.

In MSR Solutions' experience with water and sewer servicing and monitoring in British Columbia, it has been found that Average Daily Flows can be as low as 160 L/p/d in similar properties. This data has previously been used as a design basis for projects in Port Renfrew, Mill Bay, and other locations in BC. Water usage at Surfside Park Estates on Mayne Island in 2020 was 424 L/day/house, or 170 L/day/capita on a system with noted leaks and damages.[4]

Water conservation measures are mandated by the current BC Plumbing Code, which requires low flow fixtures. For example, toilets must now use no more than 6 L per flush, whereas older toilets typically use 18+ L per flush. Generic guidance documents such as the RRCW still factor in older homes, thereby providing daily flows that are

[4] Capital Region District *Surfside Water System 2020 Annual Report* (2020)

higher than anticipated for homes built to the current code. It can then be assumed that estimated water consumption will be less than the usage numbers provided in the RRCW. Having storage of potable water also ensures an adequate buffer for peak events, maintenance or incidents such as a water leak that may take the treatment plant offline.

2.4.1. Emergency Conditions

Should demand become greater than the designed storage and water runs low or out, MIHS would have to consider the following options:

1. Contact plumber to identify potential leaks or bursts in the system
2. Notify residents that water is scarce and conservation efforts need to be taken
3. Truck in potable water to replenish the storage

The water distribution network will include valving so that the network can be isolated into smaller zones to facilitate leak detection. Detailed record drawings will provide accurate locations of all water piping and fittings to assist in locating and repairing any leaks. A regular log of a flow totalizer from the well will be maintained, allowing for the operator to spot trends in increased usage that may be due to leakage.

2.5. Rainwater

Rainwater availability for irrigation can be determined by the collection surface area and rainfall data. Using the average rainfall data from 1981-2010 from the Mayne Island Climate Station, in a typical year Mayne Island will see 842 mm of rain. Allowing for 20% losses in collection, a conservative estimation of 670 L/m^2 of available rainwater can be collected. Using preliminary unit designs, an estimate of 563 m^2 of roof area can be used for a collection surface for a total of 379 m^3 of available water in a typical year.

The distribution of rainfall events on Mayne Island are seasonal in nature, with most of the rainfall occurring between October and April, and prolonged dry periods common during summer months. Total monthly rainfall available for collection (after losses) is shown in Figure 3. Irrigation demand will likely be greater than the available water through the summer months unless sufficient storage is used.

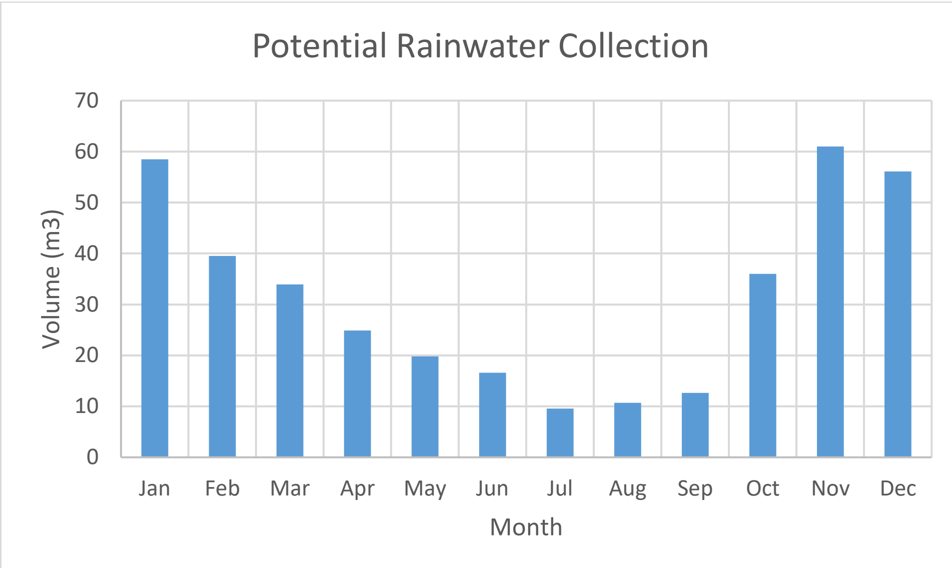

Figure 1: Potential Rainwater Collected

Rainwater collection will be used for irrigation of any garden areas. Rainwater will not require any treatment other than coarse filtration before irrigation, therefore the costs associated are generally collection and storage. There are currently no dedicated garden areas but there may be some native plants along the perimeters and possibly residents requiring access to rainwater for gardening.

3. Treatment

Based on the previous Hydrogeologist's report, the water quality samples obtained in 2020 showed a generally clean source, with only a few parameters of concern. The dissolved manganese levels at 349 µg/L exceeded the new Aesthetic Objectives from the Canadian Drinking Water Guidelines. If required based on a construction permit application with Island Health, Manganese can be removed with a media filter. Chlorine will act as an oxidant that will also reduce levels.

A source approval is to be obtained through Island Health, which will assess the risk factors of the water source and mandate minimum levels of treatment. If multiple barriers of disinfection are deemed necessary, this can typically be provided with a treatment system consisting of filtration, UV disinfection, and residual chlorination. Filtration will be provided in 4" x 20" filter cannisters with a 5 micron and 1 micron filter, which is easily maintained by opening the cannister and replacing the cartridge. The UV systems will either be simple for a typical cleaning required every 2-3 months, or a more expensive model, which will have a built-in wiper, requiring only annual maintenance. Both UV options require annual bulb changes. If the source is deemed at low risk and does not require multi-barrier disinfection, residual chlorination may still be anticipated.

Chlorine disinfection may be kept at a residual of 0.5 mg/L to minimize concerns for odour and taste. This will also mitigate regrowth within the distribution systems, thereby reducing the frequency of line flushing. Treated water will need to be stored to meet required chlorine contact times. These components (except the storage tank) will need to be installed inside a secure, watertight building. If a dedicated water treatment building is required, keeping the building under 100 ft^2 will prevent the need for additional permits and should be sufficient for the required treatment equipment.

4. Reservoir Storage

Using *Section 4.7 – Distribution Storage Reservoirs* from of the Design Guidelines for Rural Residential Community Water Systems (2012), the storage reservoir can be designed using the following:

- **Balancing Storage:** To balance the fluctuations in domestic demands and irrigation and allow for reasonable on/off frequencies of the supply pumps;
- **Fire Storage:** To provide sufficient water for the critical fire flow/duration demands in the system;
- **Emergency Storage:** To provide water in case of power outages and restriction in source supply.

4.1. Balancing Storage

Section *4.7.1 – Balancing Storage* states that the balancing storage required is the difference between instantaneous demands and the average demands should be minimum 25% of the maximum daily demand (MDD). As such, the volume required for balancing storage is 1,840L (405 iGal).

4.2. Fire Storage

Mayne Island Fire Rescue supplies their own water when a fire occurs through the use of pumper trucks and dry hydrant storage ponds. Through discussions with the Mayne Island Fire Chief, Kyle Stobart, no storage is required for this the development as the Fire Department has sufficient capacity.

4.3. Emergency Storage

Section 4.7.3 – Emergency Storage states that emergency storage provides water during events such as natural disasters, pump failure, source failure, or watermain breaks.

The emergency storage is calculated using:

$$Emergency\ Storage = 0.25\ x\ (Balancing\ Storage + Fire\ Storage)$$

As such,

$$Emergency\ Storage = 0.25\ x\ (1{,}840\ L + 0\ L)$$

$$Calculated\ Minimum\ Emergency\ Storage = 460\ L$$

The above Emergency Storage calculation results in only 460 L due to the lack of fire storage required at this site. However Emergency Storage is warranted for other considerations, such as the disruption of the well source. Taking the MDD of 7,360 L/d and considering a typical peaking factor of 2.5 for MDD relative to ADD, an average consumption of 2,940 L/d may be assumed. To provide seven days of average demand, 20,580 L of storage would be required. This will be rounded to 20,890 L to account for commonly available tank sizes (5000 iGal).

$$Recommended\ Emergency\ Storage = 20{,}890\ L$$

4.4. Total Reservoir Storage

Total reservoir storage is found using the following:

$$Total\ Storage = Balancing\ Storage + Emergency\ Storage$$

The total storage summary is shown in Table 3.

Table 3: Total Reservoir Storage Summary

Balancing Storage (0.25 x MDD)	1,840 L
Emergency Storage	20,890 L
Total Reservoir Storage	22,730 L

A minimum reservoir storage of 22,730 L is recommended. This can be achieved with NSF61 rated poly tanks, either a single 22,730 L (5,000 iGal) or two 11,365 L (2500 iGal) tanks. This storage volume can also provide chlorine contact time if multi-barrier disinfection is required by Island Health. The design shall follow the most recent version of the British Columbia Building Code (BCBC), National Building Codes and AWWA D-103-09 specifications.

4.5. Rainwater Storage

Due to the highest demand period for irrigation being during the driest months of the year, the storing of rainwater through the winter months will be necessary. Demand will be about 0.02 m^3/day or about 0.6 m^3 per month for every 10 m^2 of garden space. Gardens will only be installed bordering sections of each unit, containing native species with minor footprints. It is recommended that a landscape consultant be contacted, and storage is built to suit cost and minimal needs.

5. Wellhead and Protection

Protection of the well is critical to ensure water contamination is mitigated. Wellhead protection will be in accordance with the Drinking Water Protection Regulation and the Groundwater Protection Regulation (GPR). The well was properly installed by Red Williams Drilling with a bentonite surface seal and steel casing; and vermin proof well cap, with appropriate stick up. Any works required to modify the well shall include well head protection as per the GPR.

Salt water intrusion in this well is not anticipated to be an issue, as the well pump will also be located above sea level (HyGeo Consulting). However in support of downstream users, best practices from *Best Practices for Prevention of Saltwater Intrusion* will be utilized including the following:

- Large water storage tanks for times with peak demand;
- Low water use appliances and irrigation systems will be implemented;
- Leaks will be monitored and rectified as soon as possible;

6. Monitoring and Reporting

Water use will be regularly monitored and reported. Volume totals can be tracked from a flow meter either at the well head or located inside the treatment building. This will ensure usage is staying within the allowable limits from the license and assist with any future works by providing more accurate per capita water use data.

A well data logger will be installed for water level monitoring. Data is downloaded from the probe at the well head in digital form.

When an operating permit is issued by Island Health further reporting requirements will be laid out. Regular sampling of the treated water for quality will be required. Bacteriological sampling will be required to be submitted to Island Health, likely on a monthly basis. Any other reporting will be done as needed to the appropriate governing bodies.

7. Stormwater Management

New developments are required to prepare a stormwater management plan to obtain a building permit, typically after the site design is done. The plan requires the area and location of all impermeable surfaces before you can properly calculate the required runoff control. The objective generally is to minimize erosion and to keep stormwater runoff equivalent to pre-construction flows. Rainwater collection is planned for irrigation and can be used as a means of managing the stormwater from the property. The preliminary stormwater design is outlined in the following sections and will be further designed with the completion of the final architectural plans.

Upon completion of the final design, peak discharge and runoff volumes can be calculated. The soil properties will be obtained using a permeator test at the Building Permit Stage. Using the final design, soil conditions and models predicting future stormwater conditions, a stormwater design will be developed to ensure there is adequate storage to accommodate the difference in run off from post-development and pre-development for a 15-minute storm event. The design will include retention ponds and swales to provide storage during the storm events.

In addition to the stormwater collection, the grading plan will ensure drainage runs away from the structures towards swales and central roadways.

7.1. Site Context

During a site visit in February of 2022, it was observed by MSRS that stormwater from the upslope catchment area transitions through the property at 375 Village Bay Road. The contributing catchment consists of the steep north face of a ridge, with an estimated catchment area of at least 7.5 Ha (18.5 acres) directly contributing to the flows which transit the property, which are conveyed across Village Bay Road via two existing culverts. During winter storm events, the existing soils have been observed to be compacted and fully saturated, and therefore have a high runoff coefficient. Although forested areas are often assigned low runoff coefficients such as 0.15 (as referenced in the section below), the Ministry of Transportation and Infrastructure (MoTI) acknowledges that under saturated conditions, steep forest areas can have runoff coefficients upwards of 0.8 and therefore requires this consideration in the design of highway infrastructure[5]. It is observed that a high runoff coefficient in keeping with MoTI's conservative estimates is applicable to this catchment and contributes to stormwater management issues and concerns for downslope residents on Maple Drive.

Due to this context, it is acknowledged that responsible stormwater management is a critical aspect of the proposed development. Best practices for stormwater management as outlined in the following sections shall be adhered to in order to ensure there are no impacts on the downslope properties relative to pre-development conditions. The pre-development runoff coefficient of 0.15 used in the calculations below results in a conservatively sized retention system which likely goes well beyond merely compensating for the net change in impermeable surfaces (as discussed above, actual pre-development coefficients are much higher than 0.15). Plans for habitat restoration and retention ponds are anticipated to further reduce the intensity of runoff existing the site. Parcels are generally not responsible for the attenuation stormwater flows originating from offsite, and this would be a contentious precedent to set. However, it has been stressed by the MIHS that the proposed development intends to go well beyond the minimum requirements of accounting for the post-development onsite runoff, and to ideally provide a net benefit to the stormwater management of downslope properties.

7.2. Sediment and Erosion Control

Erosion and sediment control (ESC) procedures will be adhered to during construction. The erosion and sediment control measures will be monitored throughout the entirety of construction. Sediment and erosion control measures ensure that the quality of site run-off is maintained.

[5] BC MoTI Supplement to TAC Geometric Design Guide (2019), Table 1020.A

To improve the quality of discharged stormwater from the site and considering Section 8 of Ministry of Environment (MoE)- Province of British Columbia *General BMPs and Standard Project Considerations,* the following are proposed to control silt during the construction period in rain season:

Table 4: Silt Control During Construction

Method	Photo
A silt trap is a designated area where water that is contaminated with suspended sediment as a result of construction activity or water runoff is contained. While the water is in the trap, the sediment can settle to the bottom of the trap until it can be removed. These devices can be made using silt fence. Silt Fence is used on construction sites to help protect streams, rivers, lakes and other aquatic resources as well as terrestrial resources from contamination by silt, sediment and construction debris.	 **A Silt Trap**
Straw Wattles are an effective and economical alternative to silt fence and straw bales for sediment control and stormwater runoff. The wattles consist of 100% agricultural straw wrapped in tubular ultra-violet stabilized synthetic netting.	 **Straw Wattles**

Downstream of the construction points can be considered as an appropriate location to set up the silt fences or straw bales.

7.3. Pre-Development Condition

The land is at its highest elevation at Village Bay Road. North from the road the land slopes quite steeply for between 20 and 40 meters at which point the slope is reduced but continues to the north end of the property. Much of the property has poor drainage and results in some areas with standing water. There are no significant surface streams on the property.

The pre-development discharge can be calculated using the rational method, Q = CIA/360

Where:

Runoff flows (Q) = Total runoff volume

Runoff Coefficient (C) = 0.15 (for forested areas)

Rainfall Intensity (I) = 34 mm/hr x 130% = 44.2 mm/hr (30% additional to account for climate change)

Total Lot Area (A) = 1.2145 ha

360 = conversion factor

Therefore,

$$Pre\ development\ discharge = \frac{(0.15)\left(44.2\frac{mm}{hr}\right)(1.2145\ ha)}{360} = 0.0224\frac{m^3}{s}\ (22.4\frac{L}{s})$$

7.4. Post-Development Condition

The development of the land will create impervious areas that will increase runoff discharge. Post-development discharge is calculated using the same method accounting for all the different coefficients for different parts of development. Coefficients and areas for post-development can be seen in Table 5.

Table 5: Post-Development Runoff Coefficients and Areas

Type of Area	Area (m^2)	Runoff Coefficient
Buildings	563	0.85
Paved Areas	125	0.9
Gravel Areas	1,000	0.85
Undeveloped	10,288	0.15

By adding up the sum of each coefficient multiplied by its respected area and then multiplying by the same intensity used in the pre-development calculations, a post development runoff will be equivalent to 0.0296 m^3/s (29.6 L/s). Based on a 15 min storm duration as recommended in the BC Building Code, this equals a runoff difference of 6.527 m^3.

7.5. Stormwater Retention

A general requirement for the issuance of a subdivision approval through MoTI and building permit through the CRD is for a qualified engineer to provide a stormwater plan which is to ensure that post-development runoff is equivalent to pre-development conditions for the applicable design rainfall event. To balance the post-development runoff to pre-development runoff levels, stormwater retention basins are to be built on site. These basins will be sized to hold a minimum of 6.5 m^3 of runoff within the available freeboard above the discharge. Flow from the retention basin will be release in a controlled manner, equal to or less than pre-development flow rates by use of a control orifice. The overflow structure will be constructed to ensure an overland flow path to convey a minimum of a 100-year event in a controlled manner.

8. Summary

The following points are addressed within the report, or as noted below:

Issue	Comment
Water Source	• Well licence application for 7.36 m^3/day (5.11 L/min) • Pumping at up to the minimum sustainable yield of 3.13 USgpm will amply provide for demand while not stressing the well
Water Demand	• Demand at the highest case will be 7,600 L/day • Expected demand around 4,000 to 5,000 L/day
Managing Water Demand	• Low flow fixtures required as per BC Plumbing Code • Install recording water meter at well head for comparison to user consumption flows • There will be ongoing education to residents about water conservation measures
Storage	• A recommended 22,730 L for potable water will meet balancing and emergency demand while maintaining a safe residual • Rainwater to be discussed to suit cost and demand of irrigation
Treatment	• Manganese removal and residual chlorination anticipated. • If required by VIHA, additional treatment including UV and cartridge filtration may be included. • Equipment to be stored in secure building
Grey Water Recycling	• Constraints are additional operating costs and complexity in system impacting affordability
Wellhead Protection	• Completed in accordance with the Groundwater Protection Regulation. • Location of well pump to be above sea level

Saltwater Intrusion	• Not anticipated to be an issue on this property. • Water conservation practices are in effect for the development • The pump location is setback from the ocean and the pump zone will be set below the 120 day average draw down (plus NPSH) • Pumping will be by low volume – high frequency
Monitoring and Documentation	• Recording flow meters and dataloggers will be installed. • Data will be stored for upwards of 6 months to allow retrieval of information and reporting as required.
Stormwater Management	• To be addressed in detailed design to directed impervious areas back to ground through bioswales and retention

9. Conclusion

375 Village Bay Road can treat and distribute water to meet indoor demands for its desired population when relying on well capacity with adequate storage. A multi-barrier treatment system (filtration, UV disinfection and residual chlorination) will be required to treat the well water to meet health standards. Rainwater can be harvested for irrigation demands assuming storage requirements are met. Fire storage, balancing and emergency demands for the development will be accommodated in the 22,730 L storage reservoir.

10. Recommendations

A well treatment system with filtration and residual chlorination is anticipated to meet Island Health requirements and ensure well water is safe to consume. If multi-barrier disinfection is deemed necessary by the health officer, UV treatment may be included. The treatment equipment will need to be housed indoors. If space is not available in an existing building a small treatment shed will need to be constructed. It is recommended that redundancies are put in place to ensure water is always available. Storing spare pumps and other equipment will prevent shutdowns from malfunctioning equipment. Providing backup power generation for the treatment plant will also prevent prolonged shutdowns of the potable water system from a power disruption.

22,730 Litres of potable water storage is recommended for the development. It will meet the maximum month condition for reasonably assumed flows and can be supported in an application for a construction permit to Island Health, as it will support demand for the max population for over 7 days for responses and fixes to any emergencies or problems.

A rainwater collection system will provide a means of additional water source to help assist in irrigation demands. Because there is no requirement to treat rainwater before irrigation it is a very cost-effective means for providing the water needed to irrigate. MIHS will need to ensure adequate storage meets their decided irrigation outcomes. Usage can be minimized through Xeriscaping of the site.

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