Project Planning ▪ Civil Engineering ▪ Landscape Architecture

MEMORANDUM (3rd DRAFT)

To: Erik de Kok, Ascent Environmental

From: Martin Lewis, Cunningham Engineering Corporation

Date: 27 February, 2015 (Revised 3 April, 2015 and 29 June, 2015)

Subject: **Nishi-Gateway – Preliminary Site Water, Sewer and Drainage Infrastructure Concepts**

This draft memorandum is being provided in support of preliminary planning efforts for the Nishi-Gateway Project (Project). The memo's purpose is to summarize preliminary site water, sewer and storm drainage infrastructure concepts for the Project, and to inform continued discussion and review of water-related sustainability initiatives that may be integrated into the Project as the plan develops.

The Nishi-Gateway Project comprises the Nishi site and the West Olive Drive area, which are two separate but adjoining areas. The site limits are indicated on Attachment 1. The West Olive Drive (WOD) component of the Project comprises 10.8 acres of largely developed land within the City of Davis. The Nishi site comprises 46.9 acres of undeveloped agricultural land immediately west of the City limits. The Project proposes new land uses as summarized in Table 1 below.

Table 1 – Proposed Nishi-Gateway Land Use

Land Use - Nishi	**Bldg Area (sf)**	**Land Area (ac)**
R&D/Office	325,000	4.5
Retail	20,000	-
Residential	650 units	9.8
Parking	-	5.9
Roadways	-	3.0
Old PutahCreek	-	3.3
Stormwater Ponding	-	4.0
Open Space	-	16.4
Total - Nishi	-	46.9
Land Use - WOD		
Commercial	55,000*	-

* Estimated potential net increase relative to existing developed conditions

WATER SUPPLY

Service Provider

Properties within the WOD area currently receive water via service connections to the existing City distribution system, and will continue to do so. The Nishi-Gateway plan incorporates provisions to realign and reconstruct the segment of Olive Drive from Richards Blvd to the edge of the Nishi site, so it is expected that this street reconstruction work will be accompanied by modifications to the existing City water distribution facilities and service lines within this corridor.

The Nishi property is currently not served by a public water system. For the development of the site, connection to either to the City water system or the UCD water system is being considered. Existing UCD water facilities in the vicinity include a 10" main in Old Davis Road and a 6" main south of Solano Park. Existing City water facilities in the vicinity include 6" and 10" mains located in West Olive Drive. The City recently conducted a review of its distribution system in order to determine feasible points of connection for the Nishi site. It is our understanding that UCD has also recently embarked on such an evaluation.

In order to provide for reliability and redundancy of supply for the Nishi property, the proposed onsite public water distribution system will require at least two points of connection (POCs) to the existing City or UCD distribution system, with a looped main configuration within the Nishi site. The POCs should be to two or more lines of sufficient capacity which are physically and hydraulically remote enough from each other so as to offer adequate redundancy of supply. The combination of the existing 6" and 10" lines in Olive drive does not satisfy this requirement. As such, the City has recently studied alternatives to this configuration. The City's study calls for the replacement of approximately 3,000 LF of existing 6" and 10" pipeline along Olive Drive, from the proposed point of connection at Nishi extending east.

Within the Nishi site itself, public water mains will be primarily located within roadway corridors, but also probably traversing non-roadway areas in some locations, as conceptually shown in Attachment 2A (Option A - City) and Attachment 2B (Option B - UCD). The loop will provide the site's inside-use service connections for the planned residential/office/R&D uses, building fire-service connections, site fire hydrant connections, and possibly for irrigation service connections.

Water Demand

For the purposes of evaluating potential impacts on the City water supply facilities, the City performed preliminary water demand calculations have been performed at a planning level of detail for the new uses proposed on the Nishi site. These preliminary estimates were based on per-capita usage, type of use, and expected occupancy per square foot of building area. The estimating method and results are presented in an SB610 Water Supply Assessment (WSA) report prepared for the City by Brown and Caldwell in January 2015. The WSA addressed potential demands for four Innovation Park projects currently being considered for development in Davis, including the mixed-use Nishi site. While the projected net increase in commercial building square footage (55,000 sf) within the WOD redevelopment area was not indicated explicitly in the WSA, it may have been implicitly accounted for as part of projected demands within the City limits. The WSA-generated demands for Nishi are summarized in Table 2 below.

Table 2 – Nishi Site: Daily Water Demand per WSA estimates

Land Use	Average Day Demand (gpd)	Peak Day Demand (gpd)*	Peak Hour Demand (gpm)**
R&D/Office	21,180	27,534	34
R&D/Non-office	7,941	7,941	10
Retail	1,440	1,872	2
Retail (business use)	5,115	5,115	6
Residential	100,035	110,039	138
Subtotal	135,711	152,501	221
Open Space***	13,560	25,798	107
Total	149,271	178,299	-

* Inside use peak day/average day factor = 1.0 to 1.3, depending on use
** Inside use peak hour/peak day factor = 1.8
***Open Space irrigation based on the following:
(1) Irrigated acreage = 6.5 acres, per preliminary Nishi program, January 2015 (See below for current acreage).
(2) Peak day based on peak application rate of approx. 0.19"/day (70% of $ET_{0\ max}$)
(3) Peak hour based on an 8-hour watering window and peak hour factor of 2.0

As noted above, the WSA's estimate outside (irrigation) usage was based on an initial estimate of Open Space area of 6.5 acres. Since the preparation of the WSA, the Nishi Site plan has been revised, with the proposed Open Space area increased to 16.5 acres. Assuming an equivalent per-acre irrigation usage, a 16.5-acre Open Space area would consume about 12.4 mgy (±38 acre-feet/year).

For Nishi's inside uses, the average daily demands estimated by the WSA translate to an estimated annual usage of 49.5 million gallons per year (mgy). With the Open Space usage adjusted to 16.4 acres, the combined inside uses account for around 80% of the total 61.9 mgy usage. And of the inside uses, residential use accounts for about 74%, with the remaining 26% attributed to R&D/Retail.

The above demand estimates per the WSA are largely based on historical usage data and on standard unit demand factors in the literature, and are thought to be consistent with conventional existing developments in this locale. As such, the WSA demands represent a suitably conservative estimate of annual usage for the purposes of evaluating the water provider's capacity to produce sufficient water to serve the project. To that end, the WSA concluded that there is adequate existing and planned annual production capacity in the City's water system to accommodate the buildout of the four Innovation Parks under consideration in Davis. Further, UCD staff has indicated informally that they expect the University's system would have sufficient production capacity to serve Nishi if required.

Given that the WSA numbers may not reflect CalGreen building code requirements that will be in force at the time of the design and permitting of facilities within the Nishi-Gateway Project, this memo utilizes CalGreen (Tier 1) CalGreen Tier 1 as the baseline for the water use reduction calculations herein. Final review of projected water usage and potential reductions to same will be conducted during project design, with reference to the then-current building and/or plumbing codes.

The capability of the City's or University's distribution system to deliver the required peak flows at adequate pressure will be governed by either the peak-day + fire flow demand or the peak-hour demand. As such, gross fire flow demands have been estimated for the Project using City-standard planning level criteria. For general industrial land uses, the City's planning level guidelines yield a fire flow of 4,000 gpm. For sprinklered buildings, this demand may be reduced at the fire marshal's discretion. It has generally been our experience that incorporation of fire sprinklers can result in a 50% reduction in the required total fire flow. Assuming the use of sprinklered buildings and a 50% reduction in fire flow, the combined peak-day interior use plus fire flow demand is estimated to be approximately 2,120 gpm. Peak day inside-use + peak-day outside-use + fire flow demand is estimated to be approximately 2,140 gpm.

The City recently conducted a preliminary analysis of its water distribution system in order to gauge its capacity to deliver water at the required rates and pressures to Nishi. At the time of writing, UCD has not completed an evaluation of its distribution system to serve the Project. The Project Team will continue to engage with UCD in order to ascertain the capacity of UCD's water distribution system to serve Nishi.

Water-Use Reduction Strategies

The Nishi-Gateway Task 1 Technical Memorandum (Ascent Environmental, December 2014) proposes a goal of maximizing water and wastewater efficiency for the Project, through the use of conservation, reuse and integrated landscaping and stormwater management strategies. The objectives include meeting or exceeding CalGreen Tier 1 water use efficiency requirements for indoor water use and for reducing use of potable water in outdoor landscaping.

Conservation design measures, such as low-flow plumbing fixtures, water-efficient appliances and low-water landscape with smart/efficient irrigation can yield significant reductions in projected water use relative to minimum requirements set forth in the building codes.

For indoor use, the 2010 and 2013 editions of the CalGreen building code already contain requirements for efficient plumbing fixtures, representing a 20% reduction in design flows compared with the previous edition of the code. In order to introduce additional inside-use efficiencies beyond current CalGreen requirements, new buildings within the Project could be designed to incorporate very-high or ultra-high efficiency fixtures and appliances. Doing so could provide reduction in indoor use reductions in the region of 5%-25% compared with CalGreen Tier 1 requirements. To this end, it is suggested that the developer consider not only ultra-high efficiency fixtures, but also builder-installed water-efficient Energy-Star clotheswashers and dishwashers in the residential units. It is noted that the Energy Efficiency study for this project assumed the installations of Energy-Star appliances.

To reduce outdoor water use, it is recommended that the Project make extensive use of low-water, drought-tolerant landscaping. It is further recommended that smart irrigation controls and high-efficiency irrigation delivery systems be applied throughout the Project. It is noted that the Nishi irrigation demand computed in the SB610 WSA (see Table 2 herein) represents a usage equivalent to the maximum applied water allowance (MAWA) under the Water Efficient Landscape Ordinance – i.e. 70% of the maximum local evapotranspiration potential (ET_0). CalGreen Tier 1 requirements reduce the allowance to 65% of ET_0 for residential and to 60% of ET_0 for non-residential.

The Nishi Project landscape design will comprise a variety of plant types and densities that will have a range of water uses. For example, in certain areas a desired aesthetic may lend itself to higher water use plantings. Also, plantings within Low Impact Development (LID) stormwater features will include plants that can tolerate extended periods of inundation – such varieties may not always be the most drought-tolerant or low water use. Nevertheless, it is possible to design attractive and robust landscapes whose overall water use is less than 60%-65% of ET_0. For example, a preliminary a review of the site plan indicates that an overall mix of 55% low-water, 25% medium-water, and 20% high-water use plantings would be viable combination for the Nishi site. This mix of planting types would translate to an overall estimated water use of around 55% of ET_0. It is recommended that a target water budget at the outset of the landscape design process, and to compare the estimated demands of the proposed landscape design with the water budget as the design progresses. The Project team should collectively discuss and form landscape design goals and parameters in order to establish an irrigation water budget.

Alternative (Non-Potable) Water Sources

It is generally recommended that aggressive conservation measures be pursued to the maximum practical extent prior to seeking alternative water sources. Then, in order to achieve further usage reductions it would be necessary to additionally consider alternative water sources for non-potable uses. So, while alternative sources of non-potable water are not necessary to serve the basic demands of the Project, the Project developers and site users may wish to tap alternative sources that can be shown to be technically and economically feasible. Some potential strategies are outlined below.

<u>Strategy 1:</u> Dedicated Onsite Irrigation Well

One relatively straightforward approach to reduce outdoor potable water use on the Nishi site might be to install a dedicated irrigation well onsite, so that potable water would not be routinely used for irrigation. A dedicated irrigation well could serve the proposed open space areas and landscape areas associated with the various buildings. It could also be used for irrigating street landscaping within the proposed street corridors onsite, as well as other public common areas. The peak-hour irrigation demand for the Nishi site is currently estimated to be on the order of 100 gpm, assuming a peak application rate of 0.19"/day, although this peak demand may change as the project design evolves. Prior to opting for an onsite irrigation well, it is recommended that the potential for such a well to deliver a firm yield that meets the projected peak demand be investigated. Such an evaluation would be undertaken by a well design/installation specialist, and might include a general review of the local hydrogeology, as well as review and possibly testing of existing agricultural well installations nearby.

A dedicated non-potable irrigation system would require a 'purple pipe' distribution system on site. The system would likely comprise a looped network of mains, primarily located within or adjacent to roadway corridors, but also probably traversing non-roadway areas in some locations, as conceptually shown in Attachment 3. The loop would provide irrigation service connections throughout the site. Such a piping system, if appropriately sized, could also be used for onsite distribution of irrigation water from offsite recycled water sources, as outlined below. City public works staff has indicated that private wet utility lines are typically not allowed within public roadways. Therefore, a purple pipe distribution system that is located within roadways would be publicly owned and maintained.

Onsite well water could potentially also be used for certain indoor uses such as toilets/urinals, subject to the City's approval. The water would need to be disinfected, and delivered to the building fixtures via dual supply-side plumbing within the buildings.

Strategy 2: Tertiary Disinfected Effluent from UCD or City WWTP (aka Recycled Water/Reclaimed Water)

The existing public water distribution infrastructure (City or UCD) potentially available to the site does not include a reclaimed water distribution system. However, the City's Integrated Water Resource Study identifies recycled water as a long-term component of the City's water supply plan. The implementation timing is uncertain, but if in the future the City delivers tertiary-treated disinfected effluent from its Wastewater Treatment Plant (WWTP) to areas of the City near the Project site, then the Project may be able to use recycled City water for certain applications onsite.

The other potential offsite source of recycled water is the University's WWTP. With UCD's concurrence it may be possible to pump recycled water from the University WWTP to the Nishi site. UCD staff recently reported verbally that during the next year or so UCD will be undertaking process improvements at their plant, and that upon implementation of those improvements there is likely to be plant capacity available to provide the Nishi site with recycled water. This would entail installing a transmission line from the UCD WWTP to the Nishi site. It is recommended that the project team continue to engage with UCD with a view to UCD conducting a preliminary evaluation of the pumping and transmission main routing issues involved.

At this juncture, in-situ scalping and treatment of site wastewater has not been studied.

The obvious application for recycled water is landscape irrigation. And for WWTP plant operators this application may preferred over indoor uses, which return flows to the WWTP in a 'closed loop'. However, it is noted that the state of California is currently developing a dual-use plumbing code (authorized by AB 2282), to address the import and use of recycled water for indoor as well as outdoor applications. The intent is to broaden the usage of imported recycled water on building projects. For buildings utilizing recycled water for indoor uses, the interior plumbing would consist of two independent, unconnected water delivery systems. Potential indoor uses include residential toilet flushing, or industrial process water applications, although no potential process water users have been identified for the Project at this time.

If the Project developers and/or site users wish to maintain the option of using reclaimed water if and when it is available, it is recommended that the necessary onsite distribution piping (purple pipe) be incorporated early in the Project's site infrastructure planning and design.

The main benefits of offsite-sourced recycled water are that it has the potential to provide a long-term, reliable supply of generally consistent-quality water in sufficient quantities to serve the entire Nishi site's irrigation needs. The costs of implementing such as system would need to be studied once source availability has been confirmed, and preliminary information developed on how to deliver recycled water from the offsite source to the Nishi site. Infrastructure sizing, and hence costs, could also depend to a minor degree on the projected demands, which in turn will be a function of the landscape planting design and associated irrigation water budget.

Strategy 3: Graywater or Blackwater reclaimed onsite

Graywater includes wastewater from showers, bathtubs, bathroom sinks and clothes washers. It does not include wastewater from toilets, kitchen sinks or dishwashers. Blackwater comprises all components of building-generated wastewater.

The office/R&D land use components are currently not envisioned to be large generators of graywater and/or blackwater, so the volumes generated by these uses alone are not likely to be sufficient to economically justify onsite treatment and re-use. However, in the event that a particular user proves to be substantial producer of wastewater, and it can be shown to be economically reclaimed and reused onsite, then a user-specific reclaimed water system may be considered.

In contrast with the office/R&D land uses, the residential component of the Project could be a significant source of graywater - it is estimated that on the order of 70% of residential inside-use wastewater is graywater. Potential applications would include toilet flushing and/or landscape irrigation.

Residential graywater re-use is currently permitted by the California Plumbing Code (CPC), subject to certain requirements. For indoor use (toilet flushing), treatment is required by an on-site water treatment system approved by the authority having jurisdiction. The treated graywater is considered recycled water for the purposes of the CPC, and is subject to the Code's requirements for recycled water (it must meet California Title 22 requirements for disinfected tertiary recycled water). Graywater for outside use (specifically, subsurface irrigation) generally does not need to be treated as long as specific requirements are met to control how and where it is applied.

Needless to say, the availability of graywater for irrigation depends upon the source-buildings being occupied during the irrigation season. If building occupancy is expected to vary (for example is it is expected to drop significantly during the University summer vacation), then this should be taken into consideration when estimating graywater yield.

As an illustrative calculation of graywater potential, a three-occupant residence with a per-capita inside-use of 57 gallons per day (per SB 610 WSA report) could generate up to around 120 gpd of graywater. A portion of this could be used for toilet flushing: Assuming say 20 flushes/day at 1.28 gpf, toilet flushing could consume roughly 25 gpd (i.e. about 20% of the total daily graywater). The remaining ±95 gpd of graywater could be made available for landscape irrigation. Assuming a peak-day irrigation application rate of 0.19"/day, 95 gallons would be sufficient to irrigate roughly 750 sf of landscape.

Scaling the above calculation up to the full 650 dwelling units programmed for the Nishi site (with a projected population of 1,755), this translates to a potential to irrigate up to about 10 acres of landscape. Or, if the entire 120 gpd/du of graywater were used for irrigation, the potential irrigated acreage could increase to about 13 acres. It is estimated that graywater generation volumes (and hence irrigation potential) would be reduced by on the order of 50% if ultra-high efficiency fixtures and appliances are installed in the residential buildings.

It should be noted that plants irrigated with graywater need to be judiciously selected, in order to be able to tolerate the relatively high salinity of graywater. The irrigation water must be applied below grade in order to reduce potential for human contact, and is not recommended for watering edible root vegetables.

A residential building capturing and using graywater would need dual waste plumbing lines within the building and a means to filter, treat and store the graywater near the point of collection and re-use. As noted above, graywater treatment for inside use applications would need to be to Title 22 standards disinfected tertiary recycled water. In addition, for re-use inside the building, pumps and dual supply-side interior plumbing would be needed in order to return the gray water to toilet cisterns. For a multifamily residential building, the storage/treatment/distribution pumping functions would most likely be centralized in a single location within the building, and would be professionally operated, maintained and periodically tested by a suitably qualified entity.

<u>Strategy 4:</u> Harvested Rainwater

Harvested rainwater from rooftops can produce a relatively good-quality source of non-potable water. Because harvested rainwater is low in salts, has zero hardness and is unchlorinated, in terms of water quality it can be well suited to irrigation. It could also potentially be used for toilet flushing in buildings that are dual-plumbed on the supply side. However, for residential buildings graywater is a more plentiful and consistent year-round source, and for those reasons may be a more reliable choice than harvested rainwater for toilet flushing.

In California, the regulatory context for rainwater harvesting is evolving: The state's 2012 Rainwater Capture Act (AB1750) helped pave the way by allowing rooftop capture of rainwater without requiring a water right permit from the SWRCB. At the building code level, while CalGreen does not currently contain any mandatory requirements for rainwater harvesting, it is included in the code's Voluntary Measures as a potential means to reduce or eliminate potable water use for irrigation. For inside use, the CPC states that harvested rainwater that is treated to the State's Title 22 standards for recycled water may be used for those applications. The CPC is silent on rainwater harvesting for outside use. In most cases, harvested roof runoff probably does not need treatment other than basic screening/filtration, although the final determination should be made by the local building official.

As an illustrative estimate of harvested rainwater's potential for irrigation, it is estimated that 1,000 sf of rooftop area could harvest roughly 8,000 gallons of rainwater over the course of a 'normal' winter season, based on approximately 18" of annual rainfall and a capture rate of 75%. Since most of the irrigation season does not overlap with the rainy season, most of the captured rainwater must be stored for later use. The captured rainwater should be stored in closed tanks (rather than ponds) in order to prevent evaporation and percolation losses. The required tank storage volume equates to 80%-90% of the annually captured rain i.e. roughly 7,000 gal of tank storage per 1,000 sf of roof collection area. This estimate of required tank volume assumes that the storage tank would be fully drawn down by the end of the irrigation season, and the fill-drain cycle then repeated at the start of the next wet season.

The maximum rainfall harvesting potential for the Nishi site would be realized by utilizing all of the proposed roof area for collection (ground surfaces such as roads and parking lots being generally considered unsuitable collection surfaces, owing to water quality considerations). The preliminary Nishi site plan indicates a total building roof area of almost 325,000 sf, with roof areas of individual buildings ranging from roughly 20,000 sf to almost 75,000 sf. Based on the above assumptions, the maximum per-building tank storage that would be associated with this range in roof sizes is indicated in Table 3 below.

Table 3 – Example Rainwater Tank Sizing for Irrigation Supply

Roof Area (sf)	**Rain Captured (gal/yr)***	**Nominal Tank Size (gal)****
20,000	160,000	150,000
50,000	400,000	350,000
75,000	600,000	550,000

* Assuming annual rainfall = 18" and a capture coefficient of 0.75
** Assuming tank storage volume ≈ 90% of capture volume

For a total roof area of approximately 325,000 sf over the Nishi site, it is estimated that up to 2.6 million gallons (MG) of rainwater could be captured in a 'normal' rainfall year of 18". The total required storage volume would be on the order of 2 MG, with this storage distributed over multiple storage tanks located close to the sources – i.e. one or more tanks adjacent to each building.

A harvesting system with 325,000 sf of roof catchment and 2 MG of storage has the potential to irrigate roughly 3 to 3½ acres onsite, assuming an irrigation demand equal to 65% of ET_0. Obviously, larger areas could be irrigated if the project elects to make extensive use of low-water plantings. Delivery of stored rainwater for irrigation would be via a dedicated piped irrigation distribution system connected to each storage tank. Booster pumping would most likely be required, but in some instances gravity distribution might be possible, which would result in zero embedded delivery energy associated with the applied irrigation water.

One potential side-benefit of rainwater harvesting relates to site stormwater management. If rainwater harvesting systems are sufficiently sized to capture and store a substantial portion of the total annual rainfall, then a potentially significant stormwater management benefit can be gained by reducing the annual contribution of roof runoff to stormwater volumes that are discharged from the site. While this could reduce the overall runoff volume discharged from the site over the course of a rainy season, any reduction in required site detention ponding would need to be offset by adding an equivalent amount of detention storage to the rainwater tanks' storage capacity. That additional tank storage capacity would not be allowed to fill during the rainy season and would remain in reserve to accommodate roof runoff from the drainage design storm - typically the 100-year event.

In the Sacramento Valley, a major obstacle to use of harvested rainwater is the substantial variation in total rainfall that's experienced from year to year, such that the harvested rainwater yield carries a high level of uncertainty. This makes it generally unsuitable as a sole source of irrigation water. In addition, given the very large volume of storage required, extensive use of harvested rainwater for irrigation would be very challenging economically.

It should be noted that even if roof runoff is not directed to dedicated rainwater storage tanks for later application as irrigation water, rainwater runoff could still be considered a resource by seeking to infiltrate onsite runoff via extensive application of Low Impact Development (LID) drainage design techniques throughout the site. That infiltrated runoff may in the long-term contribute to recharging the local shallow-to-intermediate aquifers, which would likely be the source of groundwater for an onsite irrigation well, if utilized.

Summary of Water Conservation Initiatives and Alternative Water Sources

The potential of various means to reduce indoor-use is summarized in Tables 4A and 4B below. The purpose of the tabulation is to gain a sense of the general extent of the potential reductions, rather than to propose absolute volumetric reduction targets. The estimates are based on referencing CalGreen Tier 1 as the baseline, and include all of the Residential, R&D (office) and Retail uses for the Nishi site. At this juncture, the Nishi R&D (non-office) water uses have not been factored in, as insufficient information exists about the specifics of those potential uses to be able to quantify what reductions might be effected. Also not included in this preliminary reduction estimate are projected changes in usage associated with the WOD redevelopment area, because the specifics of that programmed commercial space are undefined at this time. As more information becomes available, this can be included. It is noted however that the potential WOD usage volume reductions are expected to be relatively small compared with those for the Nishi-Gateway as a whole.

Table 4A– Inside-Use Reduction (% of baseline, approx.)

Use Category	Code Baseline	Very High Eff. fixtures	Ultra High Eff. fixtures	UHEF + Non-potable*
Inside Use	CalGreen T1	6%	16%	22%

* For toilet flushing (reclaimed water, non-potable well water or graywater)

Table 4B– Inside-Use Volume Reduction (MGY, approx.)

Use Category	Code Baseline	Very High Eff. fixtures	Ultra High Eff. fixtures	UHEF + Non-potable
Inside Use	CalGreen T1	1.6	4.5	6.2

The potential of various options to reduce potable water for outdoor-use (irrigation) is summarized in Tables 5A and 5B below. As with the inside-use reduction estimates summarized above, the volumetric numbers are not intended as absolute reduction targets. These initial estimates were based on referencing 65% of ET_0 (CalGreen Tier 1 Residential) as a baseline irrigation demand. However, once a landscape water budget target has been considered and agreed upon, it is acknowledged that the overall usage target may be less than 65% of ET_0. At that time, the calculations can be updated.

In Tables 5A and 5B below, the initial estimates reductions in outdoor potable use are based on the programmed Open Space acreage (16.4 acres) for the Nishi property. There will also be some additions to the total irrigated landscape areas associated with the various buildings, roadways and parking areas. The precise extent and nature of such additional landscaping is not currently known. However, for illustrative purposes, if the landscape area coverage associated with the buildings is estimated at 50%, and if the coverage associated with roads and parking is estimated at 15%, then this would translate to ±4 additional landscape acres. Finally, it is estimated the detention and creek areas together have the potential to add another ±7 acres of landscaping. When the Nishi site plan develops in more detail, more specific information will be developed on any additional landscape areas, and that information can be included in the calculations as appropriate.

As with the inside uses, landscape usage associated with the WOD redevelopment has not been included in these preliminary volume reduction estimates, but it is expected to be a minor component of the Nishi-Gateway Project as a whole.

Table 5A – Outside-Use Potable Water Reduction (% of baseline, approx.)

Use Category	Code Baseline	Recycled Water or Irrig. Well*	Rainwater Harvesting**	Graywater Use***
Open Space (16.4ac)	65% ET_0	Up to 100%	Up to 20%	Up to 60%
OS (16.4ac) + 4ac	65% ET_0	Up to 100%	Up to 15%	Up to 50%
OS (16.4ac) + 11ac	65% ET_0	Up to 100%	Up to 10%	Up to 40%

* Assuming available recycled water capacity at WWTP, or sufficient irrigation well yield (TBD)
** Roof catchment area of 325,000 sf and ±2 MG of storage
*** Graywater collection from 650 du's (100% occupied) w UHEFs in all units and zero indoor re-use.

Table 5B – Outside-Use Potable Water Volume Reduction (MGY, approx.)

Use Category	Code Baseline	Recycled Water or Irrig. Well	Rainwater Harvesting	Graywater Use
Open Space (16.4ac)	65% ET_0	Up to 11.1	Up to 2.3	Up to 6.8
OS (16.4ac) + 4ac	65% ET_0	Up to 13.9	Up to 2.3	Up to 7.1
OS (16.4ac) + 11ac	65% ET_0	Up to 18.9	Up to 2.3	Up to 7.4

Based on the above overview of alternative sources, initial indications are that either a dedicated irrigation well or an offsite source of recycled water probably offer the greatest potential as a reliable, long-term irrigation source of consistent quantity and quality that could potentially be applied extensively for irrigation on the Project. However, regardless of whether one of these sources is utilized, there may be localized applications for graywater and possibly harvested rainwater as supplemental non-potable sources – most likely at a demonstration scale. During the detailed planning and design phases of the Project, further review and study should be conducted in order to more fully ascertain and compare the potential of the various alternative sources that may be used.

WASTEWATER COLLECTION AND CONVEYANCE

Service Provider

The West Olive Drive area currently drains to the existing City sewer system, and will continue to do so. Within the WOD area, the planned redevelopment of the properties immediately abutting the West Olive Drive street corridor will likely require new service connections. For the Nishi property, connection to either to the City sewer system or to the UCD sewer system is being considered.

If the Nishi site connects to the City sewer system, then the proposed point of connection will likely be to the existing 8" line in West Olive Drive, as indicated In Attachment 4A (Option A - City). If the Nishi site connects to the UCD sewer collection system, then the proposed point of connection may either be to a UCD sewer main within the Hotel/Conference district, as indicated in Attachment 4B-1 (Option B1 - UCD).The nearest UCD main is in Old Davis Road, just north of the UPRR railway tracks. Alternatively, it may be possible to route a new sewer outfall pipe from the Nishi site along the UPRR ROW, to a UCD point of connection that is closer to the UCD WWTP (Attachment 4B-2 (Option B2 - UCD).

Sewer Demand

As with domestic water, preliminary sewer demand calculations have been performed at a planning-level of detail for the Nishi site. The preliminary estimates were based on per-capita usage, type of use, and expected occupancy per square foot of building area. The estimates of average day sewer flows are consistent with the inside-use average daily water demands presented in the City's SB610 Water Supply Assessment report, and (conservatively) assume that wastewater flows are equal to inside domestic water use. The sewer demands are summarized in Table 6 below:

Table 6 – Nishi Site: Daily Sewer Load by Land Use

Land Use	Average Day Flow (gpd)	Peak Flow (gpd)
R&D/Office	21,180	-
Non-office	7,941	-
Retail	1,440	-
Retail (business use)	5,115	-
Residential	100,035	-
Subtotal	135,711	346,799
	I&I*	27,600
Total		374,399

* I&I = Infiltration & Inflow

Based on these assumptions the average day demand for the Nishi site at buildout will be 0.14 mgd. Applying the City-standard peaking factor and infiltration/inflow rates yields an estimated peak wet weather flow of 0.37 mgd. Potential reductions in sewer flows (relative to Code baseline) will generally reflect the reductions in inside water use indicated in Tables 4A and 4B above.

The City is conducting a preliminary evaluation of downstream conveyance capacity to gauge the existing collection/conveyance system's ability to serve the Project. City staff has reported verbally that offsite sewer upsizing may be required, possibly extending downstream to L Street or beyond. It is our understanding that the City's capacity studies are due to be completed shortly.

At the time of writing, UCD has not yet completed an evaluation of its downstream conveyance capacity. The Project Team will continue to engage with UCD in order to ascertain the capacity of UCD's sewer collection and conveyance system. The available capacity of UCD's sewer system may influence the degree to which onsite water/sewer demand reduction is pursued for Nishi.

Wastewater Treatment Plant Capacity

An evaluation of the impact of the proposed development on either the City's WWTP or UCD's WWTP plant is not within the scope of this memo. But it is our understanding that City studies have confirmed hydraulic (flow) capacity at the City plant beyond the current General Plan buildout, and that plant capacity exists to accommodate all four Innovation Center projects (including Nishi-Gateway) currently under consideration by the City. However, City studies also suggest that in terms of biochemical oxygen demand

(BOD), plant improvements would be required in order to accommodate the Innovation Center projects.

Further, UCD staff has reported informally that the UCD plant may also have available capacity to accept flows from the Nishi property.

Proposed Site Sewer Improvements

Within the Nishi property, it is proposed that a system of public sewer mains will be constructed throughout the site, primarily located within proposed roadway corridors, but also probably traversing non-roadway areas in some locations, as conceptually shown in Attachments 4A and 4B. The mains will be gravity-drained and will provide the site's inside-use service connections for the planned residential/office/R&D/retail uses.

On the Nishi property, per a 2014 site topographic survey, existing ground elevations range from around EL 54 to EL 46 (NAVD 88 datum). Based on the those elevations, and assuming that 8" mains are used throughout the Nishi site with a minimum slope of 0.0035 ft/ft, it appears likely that a sewer lift station will need to be incorporated at some location within the Nishi site. The lift station would discharge to either a gravity or forcemain outfall. The location of the lift station would depend on whether Nishi connects to the City or UCD facilities. Two lift station location alternatives are shown in Attachments 4A and 4B respectively.

STORMWATER MANAGEMENT

Existing Conditions

The existing West Olive Drive area is largely developed with urban uses having relatively high levels of impervious ground cover, and correspondingly high runoff potential. Existing local storm drain improvements are in place to manage site stormwater runoff within that area. In general, it is expected that these existing improvements will remain, with possibly some minor modifications to accommodate redevelopment of the properties abutting the West Olive Drive Street corridor. The redevelopment of those properties affords an opportunity for the incorporation of LID/stormwater quality provisions within those sites in accordance with current City standards.

The existing Nishi site is predominantly comprised of undeveloped agricultural land. The site is very flat, with existing ground elevation ranging from EL 54 near the northeast end of the site to EL 46 near the southwest end (NAVD88 datum). Most of the site generally drains to the south and southwest, towards the I-80 right-of-way, which contains an existing grassy swale.

With the exception of a short reach of Old Putah Creek, there are currently no formal drainage facilities within the limits of the Nishi property. However, the existing swale within the adjacent Caltrans I-80 right-of-way begins near the intersection of I-80/UPRR and continues northeast parallel to the highway, eventually discharging to Old Putah Creek via a culvert pipe near the northeast corner of Nishi. In addition to accepting sheet runoff from much of the Nishi site, the upstream end of the I-80 swale also receives runoff from an existing culvert under the UPRR tracks, draining an upstream area within the UCD Campus. At this time, topographic survey information has not been acquired for the I-80 swale, and its drainage characteristics have not been quantified herein.

Neither the developable portion of the WOD area or the developable portion of the Nishi site are located within a FEMA 100-year special flood hazard area. However, the short reach of Old Putah Creek lying between the WOD and Nishi sites is indicated on the current FEMA FIRM as Zone A (100-year special flood hazard area, with no base flood elevation determined).

Developed Conditions - Stormwater Quantity

The proposed drainage facilities for the Nishi site are conceptually indicated on Attachment 5.

A fundamental stormwater management requirement for the development of the WOD area and the Nishi site should be that they not result in new impacts to properties either downstream or upstream. Potential impacts may include those relating to stormwater quality and quantity. For water quantity, the Project designs should seek to limit 10-year and 100-year peak post-project discharge at the two sites' respective outlets to estimated existing levels. Upcoming State Water Resources Control Board (SWRCB) requirements also call for limiting the 2-year/24-hour peak discharge, in order to mitigate for potential hydromodifcation impacts. At the same time, project designs should not result in objectionable backwater conditions for abutting upstream properties. And for both project sites, if upstream flows are currently conveyed through the project site, then the site plans should include provisions to accommodate those pass-through flows.

Since the existing WOD area is largely developed and has a relatively high level of impervious cover, peak flows are not expected to substantially increase as a result of redevelopment. It is expected that redeveloped sites within the WOD area will either need to generally maintain exiting drainage patterns and outlets, or provide an evaluation of the possible impacts of any changes in site drainage.

For the Nishi site, the change from agricultural to urban land use will be accompanied by an increase in peak discharge on the site. In light of this, it is expected that a means to attenuate the developed site's peak 2-year, 10-year and 100-year flows will be required. This will be provided via proposed stormwater detention storage located on the Nishi site. The preliminary Nishi site plan reserves a ±4-acre area near the southwest end of the site to accommodate a centralized stormwater detention basin.

As the site plan develops, it may be possible (and desirable) to provide some or all of the required storage in a more distributed fashion, for example along the edges of the site that abut the I-80 right-of-way and/or the UPRR right-of-way. However, for present purposes, site detention storage will be considered to be lumped near the site's southwest corner. Site runoff will be collected and conveyed to this location via a system of overland conveyances and underground pipes, as conceptually depicted in Attachment 5. The detained runoff will be discharged via the I-80 swale (and/or a parallel pipe if needed) to the Nishi site's current point of discharge to Old Putah Creek, just upstream of the Creek's undercrossing of I-80.

This memo provides a first estimate of the post-project detention storage volume that would be needed on Nishi site to limit the site area's post-project 100-year peak discharge to estimated existing levels. The main purpose of this initial calculation is to confirm that the site plan contains an adequate amount of land allocated for stormwater detention. This estimate was conducted using the HEC-HMS hydrologic model, with the following basic input parameters:

- Analysis area: 46.9 acres
- Design storm: 100-year, 24-hour frequency storm (4.25" rainfall)
- Rainfall-runoff transform: SacCalc/USBR unit hydrograph method
- Lag Time: ≈ 50 minutes (existing site); ≈ 25 minutes (proposed site)
- % Impervious: ≈ 1% (existing); ≈ 80% (proposed - conservatively high initial estimate)
- Loss Method: Initial/Constant
- Initial Loss = 0.1 in
- Constant loss rate ≈ 0.15 in/hr (60% HSG 'B' at 0.18 in/hr; 40% HSG 'C' at 0.10 in/hr)
- Interception and storage of roof runoff for rainwater harvesting and use: None assumed
- Initial Nishi stormwater pond storage condition: Empty

The HEC-HMS model results were as follows:

Existing (Pre-Project) site discharge:
- $Q_{100} \approx$ 45 cfs at t=12:42
- $V_{100} \approx$ 6.4 ac-ft

Developed (Post-Project) site discharge into Nishi detention basin
- $Q_{100} \approx$ 77 cfs at t=12:22
- $V_{100} \approx$ 14.5 ac-ft

Developed (Post-Project) site discharge out of Nishi detention basin
- $Q_{100} \approx$ 38 cfs at t=12:46
- Peak Detention Storage ≈ 4.4 ac-ft

As indicated above, the peak storage volume required to limit the Nishi site area's 100-year post-project peak flows to existing levels is estimated to be between 4 and 5 acre-feet, which could be readily accommodated within the ±4 acre area identified on the Nishi site plan. In fact, the 4-acre area could - if necessary - accommodate a greater degree of detention storage (and hence greater attenuation of flows). For example, a 4-acre footprint could be configured to detain the entire 100-year post-project site runoff volume of 14.5 acre-feet if it were necessary to do so. This would represent a limiting scenario in which the post-project peak flow were very highly attenuated and released from the site at a low flowrate.

In order to make a final determination of the appropriate amount of onsite detention storage, it is anticipated that a detailed hydrology and hydraulics (H&H) analysis will be conducted at such time the site plan has been more fully developed (during Tentative Map preparation and the initial design of site improvements). At that time, the preliminary hydrology analysis will be refined and coupled with a hydraulic routing model to more fully define the configuration/sizing of the proposed site drainage facilities, indicating how they will be integrated into the final Project Site Plan.

The detailed H&H analysis for the Tentative Map application will also evaluate the flow characteristics of the existing Caltrans swale along I-80, to which the Nishi site will continue to drain. Such an analysis will require expansion of the site hydrology model to consider a potential offsite flow contribution to the swale from UCD lands upstream of the railway tracks, combined with a hydraulic analysis of the I-80 swale and its two bounding culverts. As such, the final H&H evaluation will provide a quantitative comparison the total pre- and post-project flows (comprising onsite and offsite flow contributions) at the Nishi site's effective outlet to Old Putah Creek.

Developed Conditions - Stormwater Quality

For stormwater quality, new construction within Nishi (and the WOD area) will be designed at a minimum with reference to applicable City requirements and SWRCB requirements. Such requirements call for implementation of stormwater quality management measures using a combination of LID techniques, water quality BMP's and flow attenuation measures. Accordingly, it is intended that Low Impact Development (LID) measures be integrated throughout new construction to provide stormwater quality treatment, and to provide at-source runoff reduction where feasible. Another potential benefit of infiltration-based LID features may be long-term recharge of the local shallow-to-intermediate depth aquifer. Key LID elements include the following:

1. Incorporation of at-source drainage management features:

This entails integration of small-scale distributed drainage management features such as shallow, decentralized surface ponding areas and/or rain gardens that are consciously designed into streetscapes and individual site landscapes throughout the Project area. For example, it is recommended that the Project consider - to the extent feasible - incorporating stormwater planters at regular intervals into the landscape parkway strips of proposed street sections. An at-source drainage management approach encourages the use of drainage as a design element, rather than solely as a functional requirement. In order to implement this, the Project's landscape designs and engineering designs should be developed in an integrated, fully collaborative effort.

2. Reduction of new impervious areas:

This can be accomplished with compact building footprints, alternative driveway layouts and/or materials, narrower roadway cross-sections (as appropriate), pervious pavement and efficient parking layouts. For example, in parking lots, the following elements can help reduce impervious areas:

- Efficient layouts that seek to minimize the overall area of the lot on a per-parking-space basis.

- Re-examination of conventional parking minimums and maximums, with the intention of not 'overparking' site designs.
- Construction of overflow (infrequent-use) parking areas from pervious materials.
- Exploration of shared parking opportunities for adjacent non-concurrent uses.

3. Disconnection of new impervious areas:

This can be accomplished through judicious site design that seeks to place pervious areas (landscaping and/or pervious pavement) downstream of a site's impervious surfaces (roofs and conventional pavement), with site grading/landscaping designs that provide for sheetflow from those impervious surfaces onto the pervious surface areas. It is recommended that the detailed site design explore and, where appropriate, implement drainage design solutions that avoid direct connection of roof downspouts to the receiving storm drain pipe system, and seek to provide landscape areas immediately upstream of proposed drain inlets that will receive runoff from new pavement areas.

Disconnection of impervious areas usually slows down runoff, which in turn tends to reduce peak flow rates. It also increases opportunities for stormwater filtration and infiltration, which improve water quality and reduce runoff volume.

The LID treatment control measures will likely include both flow-based BMPs (such as vegetated swales) and volume-based BMPs (bioretention planters, infiltration areas). The selection of LID measures will be a function of location and setting within the Project. These LID measures will be designed in accordance with the City of Davis Stormwater Quality Control Standards. Location, sizing and configuration of these treatment measures will be determined with the future development of the tentative map and improvement plans for the Project.

<u>LIST OF ATTACHMENTS</u>

1. Existing Site Conditions
2A. Nishi Site Domestic Water System Concept (Option A)
2B. Nishi Site Domestic Water System Concept (Option B)
3. Nishi Site Non-Potable Water System Concept
4A. Nishi Site Sewer Collection System Concept (Option A)
4B-1. Nishi Site Sewer Collection System Concept (Option B-1)
4B-2. Nishi Site Sewer Collection System Concept (Option B-2)
5. Nishi Site Drainage System Concept