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TECHNICAL MEMORANDUM

DATE:	April 2, 2015	Project No.: 011-10-15-46 SENT VIA: EMAIL
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CC:	Stan Gryczko, City of Davis	
FROM:	Chris Malone, R.C.E. #51009	
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SUBJECT:	Impacts of Innovation Center/Nishi Property Development on Wastewater Treatment Plant Capacity (Final)	

The purpose of this technical memorandum (TM) is to present an assessment of the impacts of the proposed Innovation Center (IC) and Nishi property development projects for the City of Davis (City) Wastewater Treatment Plant (WWTP). The major topics covered in this TM include:

- Executive Summary
- Proposed Development Projects
- Existing WWTP Capacity
- Impacts of Future Development
- Conclusions

EXECUTIVE SUMMARY

The analysis presented in this TM indicates that adequate flow capacity exists to accommodate General Plan buildout development, plus the anticipated flows from the four proposed development projects under consideration in this analysis. With regard to organics loadings (expressed as biochemical oxygen demand, or BOD), it appears that adequate capacity exists to accommodate General Plan buildout conditions; however, capacity may not be adequate to accommodate the four proposed development projects. A summary of WWTP capacity, and existing and anticipated future flows and loadings, is presented in Table 1.

Table 1. Summary of Existing and Future Capacity and Flow/Loading Conditions

Condition	Average Dry Weather Flow, mgd	Average Dry Weather BOD Load, lbs/day
WWTP Capacity	6.0	10,100
Existing Conditions	4.34	8,300[(a)]
General Plan Buildout	5.05[(b)]	9,440[(c)]
Remaining Capacity	0.95	660
Proposed Development Project Contributions		
Davis IC	0.19[(d)]	710[(e)]
Mace Ranch IC/Triangle	0.11[(d)]	440[(e)]
Nishi Property	0.18[(d)]	300[(e)]

(a) Includes a 5 percent safety factor.
(b) Based on City sewer flow factors and projected buildout land uses (see Table 7).
(c) Includes a 20 percent safety factor (see Table 9).
(d) Based on City sewer flow factors and projected buildout land uses (see Table 8).
(e) Includes a 20 percent safety factor (see Table 10).

PROPOSED DEVELOPMENT PROJECTS

The proposed development projects under investigation in this analysis include:

- The Davis IC, located north of Covell Blvd. west of Highway 113
- The Mace Ranch IC, located east of Mace Blvd. north of Interstate 80 (I-80)
- The Triangle, located adjacent to and immediately southwest of Mace Ranch IC
- The Nishi property, located between I-80 and the Union Pacific Railroad tracks immediately south of the University of California, Davis central campus

For this analysis, the Mace Ranch IC and Triangle projects are considered as a single project. Details associated with planned and proposed future development are specified in the document titled Draft Water Supply Assessment [Brown and Caldwell, January 2015] (“2015 Draft Water Supply Assessment”). Anticipated land uses associated with the above four projects, as well as projected development associated with City General Plan buildout conditions, are summarized in Table 2.

Table 2. Projected Land Use Totals for Future Development

Category	Units	Davis IC	Mace Ranch IC/Triangle	Nishi Property	General Plan Buildout Development
Residential	population	0	0	1,755	6,023
Residential	dwelling units	0	0	650	2,231
Office	ft^2	2,400,000	1,555,901	264,712	not specified
Non-office	ft^2	1,280,000	884,000	88,238	not specified
Office/Non-office	employees	10,536	5,633	1,412	7,500
Retail	ft^2	120,000	125,155	47,950	not specified
Retail	employees	240	250	96	not specified
Retail	customers	5,301	4,042	1,705	not specified
Hotel	rooms	200	150	0	not specified
Convention Center	visitors	1,000	667	0	not specified
Hotel	ft^2	200,000	160,000	0	not specified
Hotel	employees	66	50	0	not specified
Open Space	acres	0	0	0	not specified

Source: Draft Water Supply Assessment, Brown and Caldwell, January 2015.

EXISTING WWTP CAPACITY

The City's WWTP is currently being upgraded to ensure compliance with all existing and anticipated wastewater discharge standards. The WWTP will be nominally sized to accommodate 6.0 million gallons per day (mgd) of average dry weather flow (ADWF). ADWF is defined as the average of the three consecutive lowest-flow calendar months, which for the City usually coincide with the period of July through September. A summary of the ADWF values for the past five calendar years is presented in Table 3.

As indicated in Table 3, the 5-year average of ADWF values for the period of 2010–2014 is 4.34 mgd. The lowest ADWF value during that period was 3.78 mgd, measured in 2014. That number appears reflective of the strict water conservation measures implemented throughout the City during the severe 2014 drought conditions. That conclusion is supported by the fact that WWTP influent BOD concentrations were proportionally higher in 2014 versus previous years. (A reverse correlation between WWTP influent flow and BOD concentration is expected.) The calculated BOD loads in pounds per day (lbs/day) show less variability than either the flow or BOD concentrations during the same period due to the off-setting effect of the latter two parameters on each other.

Table 3. Davis WWTP Influent ADWF and BOD Values, 2010–2014[a]

Year	ADWF, mgd	BOD, mg/L	BOD, lbs/day	Months
2010	4.55	198	7,500	July–September
2011	4.71	205	8,100	August–October
2012	4.26	230	8,200	July–September
2013	4.42	205	7,600	July–September
2014	3.78	258	8,100	July–September
5-Year Average	**4.34**	**219**	**7,900**	**—**
Coefficient of variation[b]	8.2%	11.4%	4.1%	—

[a] *Source: https://ciwqs.waterboards.ca.gov/ciwqs*
[b] Defined as the standard deviation divided by the arithmetic mean; indicates the degree of variability in the data.

Given the relatively high variability in ADWF measurements over the last five years, there is some question as to what actually represents the "current" ADWF value. Because the 2014 value was unusually low as compared to previous years, the use of the 2014 ADWF may be inappropriately low for assessing available WWTP capacity. On the other hand, the inclusion of the 2014 value in a 5-year average seems reasonable in calculating a sufficiently robust ADWF value, given the potential for drought-related water use reductions every few years.

Given these considerations, for this analysis, the 5-year average ADWF value for the period of 2010–2014 (i.e., 4.34 mgd) is assumed to represent current ADWF conditions. Growth within the City has been minor over that span, so the flow generating land uses within the City have remained relatively constant during that period. Given an existing ADWF of 4.34 mgd and a WWTP capacity of 6.0 mgd, the estimated available ADWF capacity of the WWTP is 1.66 mgd, or 28 percent of design capacity.

Another way to assess remaining WWTP capacity involves consideration of BOD loadings rather than flows. The use of BOD loadings as an indicator of capacity is relevant because certain key treatment processes (namely secondary treatment facilities) are sized to handle organic loadings rather than flow. As per the document titled Basis of Design Development for WWTP Improvements Project, dated September 25, 2013, the design average dry weather BOD loading is 10,100 lbs/day. (It should be noted that sizing of secondary facilities is driven more by maximum month loadings rather than average loadings. However, it is generally assumed that the proportionality between average and maximum month BOD loadings remains constant over time, such that the use of average BOD loadings to assess available WWTP capacity remains valid.)

Assuming the average BOD loading for the period of 2010–2014 represents current conditions (in a manner similar to the ADWF values for that same period), then the existing average dry weather WWTP influent BOD loading is 7,900 lbs/day, as shown in Table 3. However, given the variability in the BOD loadings over the past five years, and given the variability inherent in influent BOD sampling, a 5 percent safety factor is assumed when estimating existing BOD loadings. Therefore, the existing average dry weather WWTP influent BOD loading is assumed to be 8,300 lbs/day for this analysis. The use of this value implies that 1,800 lbs/day of average dry weather BOD loading are available for future development.

IMPACTS OF FUTURE DEVELOPMENT

For this analysis, the projected impacts of future projects on the WWTP are estimated using the following three methodologies:

- Indoor Water Use Basis
- Land Use and Sewer Flow Factor Basis
- BOD Loading Basis

Indoor Water Use Basis

One option for estimating average wastewater flows from the proposed development projects is to assume that the generated wastewater is either equivalent or proportional to the projected indoor water use. For this analysis, it is assumed that indoor water use equates to the rate of wastewater generation. This assumption is generally valid where little or no indoor water is used for commercial or industrial process operations, and is thus considered applicable to the City.

The indoor water use associated with future General Plan buildout development is estimated in the 2015 Draft Water Supply Assessment. That document presents total projected water use on an annual average basis, and then assumes that indoor water use represents 49 percent of residential use and 46 percent of commercial/industrial/institutional uses. Assuming that indoor water use equates with wastewater generation, the predicted wastewater flows from General Plan buildout development are summarized in Table 4.

The projected indoor water use associated with each of the four proposed development projects is estimated in the 2015 Draft Water Supply Assessment, and those estimates are presented in Table 5. Again assuming that indoor water use equates with wastewater generation, the predicted wastewater flows from the proposed development projects is estimated to be 0.66 mgd.

Table 4. Estimated Wastewater Generation from General Plan Buildout Development

Source	Water demand, acre-feet/year[(a)]	Indoor Use Percentage[(a)]	Wastewater Generation, mgd
Residential, Single-Family	315	49	0.28
Residential, Multiple-Family	276	49	0.25
Commercial/Industrial/Institutional	213	46	0.19
Total	**804**	**—**	**0.72**

[(a)] From Draft Water Supply Assessment, Brown and Caldwell, January 2015.

Table 5. Projected Indoor Water Use for the Proposed Development Projects	
Proposed Development Project	Average Indoor Water Use, mgd
Davis IC	0.322
Mace Ranch IC/Triangle	0.203
Nishi Property	0.136
Total	**0.661**

Source: Draft Water Supply Assessment, Brown and Caldwell, January 2015.

Combining the results from Tables 4 and 5 produces a total estimated wastewater generation from future development of 1.38 mgd. However, given the uncertainties associated with future development, a 20 percent factor of safety is conservatively assumed, which produces a total estimated wastewater generation from future development of 1.66 mgd. This result exactly matches the estimated available WWTP ADWF capacity of 1.66 mgd discussed above. It thus appears that the WWTP can accommodate all future development, including for the proposed development projects, according to this flow estimation method.

Land Use and Sewer Flow Factor Basis

Another approach used to estimate wastewater generation involves coupling future land use estimates with associated sewer flow factors. The land uses associated with the proposed development projects are indicated in Table 2 above. The City Sewer System Management Plan, dated August 2012, specifies sewer flow factors for a range of land uses of which those relevant to this analysis are summarized in Table 6.

Table 6. Sewer Flow Factors Relevant to the Proposed Development Projects			
Description of Source	Type of Use	Unit	Design Flow, gal/day/unit
Residential, Single-Family	Residential	Dwelling Unit	330
Residential, Multiple-Family	Residential	Dwelling Unit	230
Hotel	Commercial	Employee	15
Hotel	Commercial	Guest	55
Office	Commercial	Employee	15
Retail	Commercial	Employee	15

Source: City Sewer System Management Plan, August 2012.

While the 2015 Draft Water Supply Assessment does not specify the number of future single-family versus multiple-family units to be added to the City service area, it does specify the total number of residential units to be added (2,231), and it also specifies the number of future water supply connections to be added. Specifically, 815 future additional single-family water supply connections are indicated. If it is assumed that a one-to-one correspondence exists between single-family units and single-family connections, then a total of 1,416 future additional multiple-family units can be inferred. The 2015 Draft Water Supply Assessment also specifies 7,500 future employees to be added, although it does not make any assumptions about future retail customers associated with future commercial development. For this analysis, flows associated with future retail customers are considered to be non-significant. Given these assumptions, the ADWF associated with General Plan buildout development is indicated in Table 7.

Table 7. Projected Wastewater Generation from General Plan Buildout Development

Category	Flow Factor, gpd/unit	Quantity	Average Flow, mgd
Residential, Single-Family	330	815[a]	0.27
Residential, Multiple-Family	230	1,416	0.33
Employees	15	7,500[a]	0.11
Total	—	—	**0.71**

[a] From Draft Water Supply Assessment, Brown and Caldwell, January 2015.

This same method can be used to estimate future wastewater flows associated with the four proposed development projects specified above. The City Sewer System Management Plan does not specify sewer flow factors for either retail customers or convention center guests, both of which are potentially significant for the Davis IC and Mace Ranch IC development projects. However, the 2015 Draft Water Supply Assessment specifies indoor water use factors of 3 gpd per customer/guest for both. That value is used in combination with sewer flow factors in Table 6 and the land use quantities shown in Table 2 above to produce projected wastewater generation rates for the four projects, which are shown in Table 8.

Table 8. Projected Wastewater Generation for the Proposed Development Projects

Project	Average Flow, mgd
Davis IC	0.193
Mace Ranch IC/Triangle	0.111
Nishi Property	0.177
Total	**0.481**

Combining the results from Tables 7 and 8 produces a total estimated wastewater generation from future development of 1.19 mgd. However, given the uncertainties associated with future development, a 20 percent factor of safety is again assumed, which produces a total estimated wastewater generation from future development of 1.43 mgd. Given the estimated available WWTP ADWF capacity of 1.66 mgd discussed above, it appears that the WWTP can accommodate all future development, including the proposed projects, according to this flow estimation method.

BOD Loading Basis

A third way to assess the impacts of future development on the WWTP involves considering future BOD loadings entering the WWTP. At present, data are not available that distinguish between the BOD content of residential versus commercial/institutional sources within the City. However, for a non-industrial community such as Davis, commercial/institutional wastewater tends to be very similar to residential wastewater in character, such that the two may be considered roughly equivalent.

As noted above, the existing WWTP influent average dry weather BOD loading is estimated to be 8,300 lbs/day (including a 5 percent safety factor). The 2015 Draft Water Supply Assessment indicates that 86 percent of existing indoor water use is attributable to residential development, while 14 percent is attributable to non-residential development. Assuming again that indoor water use equates with wastewater generation, and assuming that residential and non-residential wastewater are of equivalent strength (i.e., BOD concentration), then 7,100 lbs/day of dry weather BOD loading is coming from residential sources.

The 2015 Draft Water Supply Assessment shows a total of 26,596 existing dwelling units as of 2013. Dividing the existing residential dry weather BOD load of 7,100 lbs/day by the number of existing dwelling units produces a residential unit BOD loading factor of 0.267 lbs/day per dwelling unit. For this analysis, it is assumed that unit load applies to all future residential dwelling units also. (It should be noted that due to higher vacancy rates in the summer months, this unit BOD loading factor is lower than what would occur at other times of year. However, the WWTP design includes an allowance for higher loads during the school year, and all such allowances are preserved in this analysis.)

With regard to future non-residential development, it is more difficult to estimate a unit BOD loading factor because there is no clear non-residential “unit” to which such a calculation can be applied. Therefore, for this analysis, future non-residential BOD loads are estimated by applying the existing average influent BOD concentration (219 mg/L, from Table 3 above) by the indoor water use rates indicated in the 2015 Draft Water Supply Assessment.

For General Plan buildout development, the estimated BOD loadings are indicated in Table 9. For the four proposed development projects, the estimated BOD loadings are indicated in Table 10. However, given the large number of uncertainties associated with future development, a 20 percent safety factor is added to the results.

Table 9. Projected Future BOD Loads for General Plan Buildout Development[a]

Category	Projected BOD Load, lbs/day	Plus 20 percent Safety Factor, lbs/day
Residential	600	720
Non-Residential	350	420
Total	**950**	**1,140**

(a) Based on residential dwelling unit count and non-residential indoor water usage, as specified in the Draft Water Supply Assessment, Brown and Caldwell, January 2015.

Table 10. Projected Future BOD Loads for Proposed Development Projects[a]

Proposed Development	Projected BOD Load, lbs/day	Plus 20 percent Safety Factor, lbs/day
Davis IC	590	710
Mace Ranch IC/Triangle	370	440
Nishi Commercial	70	80
Nishi Residential	180	220
Total	**1,210**	**1,450**

(a) Based on residential dwelling unit count and non-residential indoor water usage, as specified in the Draft Water Supply Assessment, Brown and Caldwell, January 2015.

The results in Table 9 indicate that the WWTP has sufficient capacity to support all General Plan buildout development. However, when combined with the four proposed development projects, it appears that WWTP capacity would not be sufficient, even without the inclusion of a 20 percent safety factor.

CONCLUSIONS

Based on flow considerations alone, it appears that the WWTP would have the capacity to accommodate flows from all future General Plan buildout development, plus the flows from the four proposed development projects under consideration in this analysis. Based on BOD loading considerations, adequate capacity apparently exists to accommodate General Plan buildout conditions; however, capacity may not be adequate to accommodate the four proposed development projects.

To address the above concerns would involve some combination of steps to ensure that the BOD loading capacity at the WWTP is adequate to handle all future loading conditions. Those steps may involve expansion of the WWTP, or other steps necessary to ensure adequate capacity. If WWTP expansion or other costly measures are ultimately required, decisions will need to be made as to who is responsible for those costs, how those costs are shared, and when the necessary outlays occur.