MEMORANDUM

Summary of Design Considerations and Design Criteria for Donner Summit Wastewater Treatment Plant

To: **Board of Directors**
From: **Bill Quesnel, PE Operations Manager**
Subject: **Summary of Design Considerations and Design Criteria for Donner Summit PUD Wastewater Treatment Plant**
Date: **December 11, 2010**

Purpose

As the Sierra Lakes County Water District Board (Sierra) discusses the various funding options and associated costs for Sierra's share of the project cost, there will inevitably be questions concerning the scope of the proposed improvements. This document is intended to provide information to consider when discussing the design criteria for the Donner Summit PUD Wastewater Treatment Plant upgrades. This memorandum was written to provide a condensed, laymen's version of the *DSPUD Wastewater Facilities Plan* (Plan) dated May 2010, the flow/load criteria contained in Eco:Logic's *Technical Memorandum No. 1, Design Flows and Loads* (Flows and Loads) dated August 10, 2010 and a draft version of *Technical Memorandum No. 4, MBR Process Design* (MBR Design) dated October 26, 2010.

Plant Design Criteria

There are two distinct primary criteria used to design any wastewater treatment plant:

- *Load* is the total mass, in pounds of various constituents, in the plant influent. The primary concerns are BOD (biochemical oxygen demand) and TKN (total Kjeldahl Nitrogen) the source of ammonia and nitrate in the plant effluent. The removal of these constituents is primarily done through biological processes.
- *Flow* is measured in MGD (million gallons day) and is the volume of liquid that enters the plant and ultimately discharges to either the river or spray irrigation fields.

There are many time periods to consider when determining the plant's required capacity in terms of loads and flows. The three most relevant are: Peak Day (PD), Average Day Maximum Week (ADMW) and Average Day Maximum Month (ADMM). To determine the design load and flow information, Eco:Logic reviewed actual plant data from 2002 to 2010. To project the increase in load and flow resulting from the additional 671 Equivalent Dwelling Units (EDUs) requested by both districts (471 Donner and 200 Sierra), the existing data were analyzed on a per unit basis for each district. The existing values were then multiplied by the number of new EDUs to determine the total increase the plant is expected to experience with the added units.

Load

The quantity of BOD and TKN entering the plant is dependent upon the occupancy of the residences connected to the system and obviously much higher on weekends and during the longer holiday periods such as Christmas-New Years, Presidents Week and Easter Week. The Flows and Loads document established a peak day BOD load of 900 pounds and an ADMW load of 780 pounds/day for the existing connections and 1,298 pounds/day and 1,125 pounds/day respectively for all connections. The BOD is not measured by the DSPUD continuously, but rather twice/week. Until 2008 the samples were taken on Mondays and Wednesdays and in the

last two years on Sundays and Wednesdays. This sampling frequency is likely not representative of the actual weekly value so an adjustment factor using a weighted average was developed to compensate for the higher loads on weekends.

The load treatment capacity of the plant is solely a function of its ability to process raw sewage and remove contaminants to a level that the discharged water meets the standards established by the regulatory agencies. The primary method of removal of BOD is a biological process wherein bacteria consume the organic material. Ammonia is present in the influent and produced in the treatment process. Nitrate is produced as the ammonia is oxidized and then removed by the same bacteria that remove the BOD. The new permit includes stringent discharge standards for daily and monthly limits of BOD and ammonia and monthly limits of nitrate. The ammonia limit is significantly more stringent than the previous permit requirement. The current plant was not able to consistently meet the previous ammonia and nitrate limits.

The primary components/processes necessary to successfully treat the load, and meet the permit requirements, include:

- **Influent Conditioning:** The effectiveness of the biological activity is highly dependent on the temperature and chemistry of the incoming wastewater and requires bacteria populations that are large enough to consume the incoming BOD and remove the ammonia and nitrate. The population will be artificially "built-up" during the transition from fall to winter when the BOD and TKN loads entering the plant can increase by as much as a factor of five from mid-week to the weekend. The buildup will occur at the same time the water temperature is decreasing, which slows bacteria growth, so the project proposes to construct heating and chemical feed improvements to condition the influent and build the bacteria populations.
- **Treatment Capacity:** The bacteria are primarily located in two reactor basins that are the existing "Plant 1" and Plant 2". These basins will be reconfigured with baffles to create aerobic and anoxic zones. The combined volume of the two tanks (510,000 gallons) is slightly greater than required when all future EDUs are connected; no additional reactor basin volume is proposed in the plant upgrade.
- **Sludge Handling:** The growth of bacteria and the undegraded influent solids results in the creation of sludge in the bottom of the basins. The sludge is removed via pumps and stored in an existing tank where it continues to biologically degrade. During the summer the remaining sludge is dewatered in drying beds and disposed of at a landfill. No capacity improvements are proposed for the tank or beds as part of the upgrade, but systems to handle the sludge will be improved.

Flow

While the plant is designed to treat a specific BOD and TKN load through a biological process, the hydraulic design/capacity is substantially independent of the load and solely based on the amount of liquid that enters the plant. The source and magnitude of the flow are a function of occupancy and/or inflow and infiltration (I&I), depending on the season. The Plan reviewed the largest 20 weekly flow events between 2002 and 2010 and found that an event occurring in January 2006 resulted in a peak day flow of 0.97 MGD and a seven-day rolling average *high* flow of 0.61 MGD. As described previously for loading, this information was extrapolated to include the future EDUs, and design values of 1.27 MGD (PD) and 0.80 MGD (ADMW) were established. The Plan also identified a *typical* ADMW flow of 0.43 MGD (current) and 0.62 MGD (future); however, the decision to use the January 2006 event was based on the fact that

during that event the maximum one day rainfall amount was 4.25 inches (measured in Truckee) while the 16-day total was 14.4 inches. The one day total was equivalent to a 1 in 18-year event (6% chance of occurring in any one year) while the return interval of the storm was 1 in 11-years (9% chance). These relatively short return intervals cannot be dismissed as occurring too infrequently to consider in the design of the plant. As an example, the Central Sierra Snow Lab measured a 24-hour total of 5.64 inches of rain on October 24, 2010.

The majority of the plant components are sized based on flow rather than load criteria. Major systems include equalization storage, membrane capacity and the disinfection system.

- **Equalization:** The need to equalize the flow into the plant is agreed by all stakeholders and the required volume has been discussed at length. The Joint Committee increased the total equalization volume to 0.90 MG (0.20 MG exist + 0.70MG new), as compared to the Plan's recommended 0.82 MG, resulting in a 350% increase over the current volume of 0.2 MG. As a general rule, 20% of the equalization volume is unavailable as a minimum amount of water is maintained in the tank for mixing and aeration of the influent, leaving an effective volume of 0.72 MG.

  The amount of available storage at any one time must be considered from a practical standpoint; there is a significant difference in theoretical vs. actual storage requirements and Chapter 8 and Appendix B of the Plan go to great lengths to explain the sizing process. The theoretical requirement is based on hindsight, allowing calculation of the volume that would have been required over seven days *after* the daily flows for those seven days are known. In practice, equalization is based on flows that are *expected* to occur during the coming week; in a perfect circumstance the operator would set the flow rate through the plant at the seven day average *before* the seven days occurred. Clearly that is an impossible expectation with the result being the amount of wastewater in storage and flow rate through the plant are different than the hindsight theoretical analysis. To fully utilize the benefits of equalization, the storage volume should be used to the maximum extent possible to provide uniform flow or at least minimal variations at all times and under all influent conditions. For instance, following peak holiday weekend it would not be unreasonable to expect the equalization tanks will contain a significant amount of wastewater with the intent of maintaining a constant flow rate during the low population mid-week period, leaving a relatively small amount of storage available for an unforecast storm/flow event.

  From a practical standpoint, the construction of a new equalization tank greater than 0.70 MG in size is problematic from a site constraints perspective. The new tank will be located downstream of the existing reservoir and filled by gravity via an "overflow" system when the 0.20 MG storage capacity is exceeded. Because the height of the new tank is fixed (to allow gravity flow), doubling the volume of the reservoir to 1.40 MG would necessitate the diameter being increased by about 40 percent with additional environmental impacts related to site disturbance and grading. During periods when the flows are low, i.e. the Fall, the new tank will be emptied to eliminate aeration and mixing costs.

  Finally, from an economic standpoint, a comparison of the capital cost of a very large equalization system vs. other plant improvements (i.e. flow dependent equipment) is made in Chapter 8 of the Plan. An economic analysis shows a cost:benefit ratio of less

than 1:1 when the amount of active storage (total volume less 20%) exceeds 0.50MG (the project proposes 0.72 MG).

- **Membrane Capacity:** After sufficient residence/treatment time in the reactor basins, the liquid will enter newly constructed basins that hold the membrane units. The membranes have microscopic sized openings that in effect filter the treated liquid. There will be three or four small basins, depending upon the selected manufacturer, with each basin having an equal capacity. This multiple basin configuration, as compared to one or two tanks, allows ease of maintenance of portions of the membranes while keeping the plant on-line but also allows the operators to "turn down" the plant during periods of low flow. Membrane life is controlled by the hydraulic loading; periodically removing some membranes from service will extend the period between replacement.

  With a membrane treatment system, all liquid that flows through the plant **must** flow through a membrane before being discharged, as compared to a clarifier system that can be allowed to "overflow" during an extraordinary flow event. This limitation mandates the installation of an N+1 System meaning that the number membrane basins is one greater than would otherwise be required by the expected flows. This factor of safety is necessary to accommodate peak flow events beyond the design and/or operation of the plant with one unit out of service for maintenance or malfunction.

- **Disinfection System:** Ultraviolet light will be used for final disinfection of the liquid before it is discharged to the river or irrigation system. The design of the UV system assumes a certain dosage of light waves penetrating the water at a flow of 0.80 MGD. At discharge rates greater than the design flow, the dosage will be less than "perfect" but because of the membrane filtering capacity the discharge is expected to meet the coliform limits established in the permit.

Alternatives to an MBR System

The Facilities Committee determined that reliance on the Accu-Web system to meet the new discharge requirements is not an acceptable risk to either district for the following reasons:

- lack of product support and discontinuance of the current design by the manufacturer
- poor performance of the system, despite interim fixes during the initial installation and recent plant improvements, has resulted in the discharges from the plant being out of compliance with the previous permit requirements
- the April 2014 deadline to meet the new discharge standards does not provide sufficient time to implement other conditioning improvements (heating, ammonia and carbon feed) and then "experiment" with the "web" system to see if it will work. The Regional Board has indicated that fines will be levied if the plant does not comply by April 2014.

Table 2-10 of the Plan ranked the various upgrade alternatives on a number of criteria. The Committee considered this information and visited three other treatment plants (Colfax, Truckee and Kirkwood) to discuss technologies, permit compliance and operational issues with the plant operators before deciding that a Membrane-Bio-Reactor/Ultra-Violet system best met the current and future needs of the Districts. By all accounts the MBR biological system is the preferred choice because:

- the Design Engineers have the highest level of confidence in that technology
- the technology has been extensively proven in thousands of plants throughout the world
- MBR is a robust and reliable system

- MBR provides a higher level of treatment than other systems which is helpful in meeting both existing and anticipated future discharge requirements
- MBR has the smallest footprint and is the easiest to expand

System Modeling

Eco:Logic/Stantec has modeled the proposed improvements using the Bio-Win software under two operating scenarios:

- The peak week loading as a steady-state (i.e. continuous) input. This scenario is important to show the plant will meet discharge requirements during back-to-back peak weeks that may be experienced during an extended Christmas-New Years holiday.
- An extended simulation modeling of seven months (September 2007 through March 2008) using the actual daily loads scaled up to include the additional EDUs showed the plant will meet the standards. An interesting result was that the amount of ammonia and carbon needed to grow the bacteria population was less than originally anticipated/expected.

Summary

Sierra has received questions from property owners and summit stakeholders relative to the level of added capacity being enabled by the proposed upgrade and expansion of the DSPUD wastewater treatment plant (WWTP). The basic concern is that the efforts to provide for additional users (EDUs) may be inadvertently adding capacity that will accommodate large numbers of extra EDUs-- paid for by us, not future developers.

The treatment capacity of the plant is a function of its ability to treat a certain amount (pounds) of BOD using a biological process. The process will occur in existing tanks that are only slightly larger than required after connection of all future EDUs requested by the two Districts. The hydraulic capacity of the various components has little effect on the plant's ability to meet discharge requirements. The quantity of BOD on any given day is not affected by abnormally high or low flows conditions; the concentration may vary but the pounds of organic matter remains consistent.

The State of California has not established design criteria for wastewater treatment plants and in fact will not review the design of this particular project. It is up to the Design Engineer to establish the equipment and performance criteria and the Districts will be "left holding the bag" if the planned improvements do not work and the discharge requirements are not met. Significant scenario modeling using Bio-Win Software and other methods show the improvements will work as proposed.