Appendix I
Analysis of Current and Future Steamboat Creek Water Quality

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Application for Clean Water Act Section 404 Permit SouthEast Connector

Prepared for
Department of the Army
United States Army Corps of Engineers

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Background

Steamboat Creek is a Class D water body per Nevada Administrative Code (NAC) Section 445A.127, defined as waters or portions of waters located in areas of urban development and/or highly industrialized or utilized for agriculture, or a combination of all the above and where effluent sources include a multiplicity of waste discharges from the highly altered watershed. Class D water body's typical beneficial uses include noncontact recreation, aquatic life, propagation of wildlife, irrigation, watering of livestock, and industrial supply. The Steamboat Creek includes an additional beneficial use of contact recreation. The water quality standards of Steamboat Creek are set according to its Class D status and include the following:

- Temperature: Single values less than or equal to 34 degrees Celsius.
- pH: Single values between 6.5 and 9.0
- Total Phosphorus: Single values less than or equal to 0.33 milligrams per liter (mg/L) as P
- Dissolved Oxygen (DO): Single values greater than or equal to 5.0 mg/L
- *E coli*: Annual Geometric Mean less than or equal to 126 No./100 milliliters (mL) with single values less than or equal to 576 No./1,000 mL

Additionally, Steamboat Creek falls under NAC 445A.121 "Standards Applicable to All Surface Waters," which limits the concentrations of arsenic, barium, boron, cadmium, chromium, cyanide, fluoride, lead, selenium, silver, copper, and zinc to water quality consistent with the mandatory requirements of the 1962 Public Health Service Drinking Water Standards and to Secondary Drinking Water Regulations maximum contaminant levels (MCLs). Because concentrations of arsenic, boron, iron, and zinc have been detected within Steamboat Creek at concentrations exceeding these water quality standards, the creek is included on Nevada's 2006 303(d) Impaired Waters List (List). Steamboat Creek was also previously on the 303(d) List for mercury and total phosphorous; however, concentrations of these chemicals were below the water quality standards when the 2006 List was developed. The chemicals of concern during the Southeast Connector construction/Steamboat Creek realignment project consist of arsenic, boron, iron, zinc, mercury, and total phosphorous. The water quality standards for the contaminants of concern (COCs) are provided in NAC445A.144. Methyl mercury has also been detected in the creek and sediment from the stream banks and, although no standards are provided in NAC445A.144, will be included as a COC. The mercury issues are addressed in the Soil Management Plan (Appendix K); this appendix addresses the nutrients and phosphorus issue of the water quality. Historical data were utilized for these analyses.

The SouthEast Connector (SEC) project has the potential to affect the water quality of Steamboat Creek and its loading of pollutants to the Truckee River in three ways: short-term impacts during construction, long-term impacts from runoff from the proposed roadway, and long-term impacts from the proposed creek stabilization and wetland mitigation proposed to be constructed as part of the project. Short term impacts during construction will be mitigated through implementation of best management practices (BMPs) and mandated stormwater pollution and prevention measures (a Stormwater Pollution Prevention Plan is provided as Appendix B to the Section 401 permit). Sediment and other pollutants generated on the roadway post-construction that could potentially negatively impact water quality will be mitigated by permanent stormwater controls such as riprap armoring, stabilization controls, bio-swales with riprap check dams, and vegetation stabilization. The proposed stream restoration and wetland mitigation that will be constructed along with the roadway are expected to improve the water quality of Steamboat Creek over the

long term via project components such as designed wetlands, erosion controls, weed management, bank stabilization, and stream embankment restoration. These components are expected to reduce sedimentation along the stream and decrease localized erosion into the creek and improve the water quality of runoff into the stream.

Construction Impacts

The BMPs and pollution controls are designed according to the Truckee Meadows Regional Stormwater Quality Management Program's (TMRSWQMP) *Construction Site Best Management Practices Handbook* (Kennedy Jenks, 2008). They are detailed in the preliminary SWPPP presented as Appendix B to the Section 401 document.

Roadway Stormwater Impacts

Stormwater pollution controls have been designed according to the TMRSWQMP's *Structural Controls Design Manual* (Kennedy/Jenks, 2007-2008) and *Low Impact Development Handbook* (Kennedy/Jenks, 2007). Bioswales designed to capture, treat, and convey onsite stormwater will be the main type of permanent stormwater quality treatment. The swales will convey and treat the peak onsite runoff resulting from the 2-year design rainstorm (the water quality flow rate (WQ_F) as defined by the TMRSWQMP) and convey the peak onsite runoff resulting from the 5-year design rainstorm with 0.5 foot of freeboard. The swales will have a bottom width of 2 to10 feet, minimum longitudinal slopes of 0.3 percent, and side slopes of 4:1 except where constrained by right-of-way. The swales will retain the onsite water quality volume (defined by TMRSWQMP as 0.6 inch of rainfall x (0.05 + 0.009* impervious area of the contributing onsite catchment in square feet)/12)) with riprap check dams.

The bio-swales will be vegetated with a drought-tolerant, native grass to improve the pollutant removal efficiency benefits of the swale. Vegetation is anticipated to be successful because it is likely that the root zone will have regular access to the higher groundwater within the project area. Irrigation is not proposed, and the vegetation will not require mowing. Maintenance of the swales is expected to be limited to weed control and removal of trash. Weed removal will be the main maintenance concern until vegetation develops. Significant erosion or deposition is not anticipated during frequent rainfall events because longitudinal slopes are shallow, and off- and onsite flows are generally separated. Bio-swales should be inspected after major runoff events where the entire area becomes submerged from offsite runoff and sediment deposition is increased.

Additional permanent stabilization features include the following:

- Riprap armoring of portions of the roadway embankment with slopes greater than 2:1
- Revegetation of embankment slopes
- Riprap aprons of storm drain and small culvert outlets
- Gravel mulch stabilization of ditches and at expected points of erosion adjacent to the roadway including at all barrier rail and curb ends that convey a significant amount of runoff, and at low points within the crown section to minimize the rilling that typically occurs from flow concentration
- Riprap or articulated concrete block stabilization at all major culvert outlets

Water Quality Enhancement

As discussed above, the water quality of Steamboat Creek is significantly impaired in the existing conditions through the project area. Historical data collected by NDEP show that the Steamboat Creek itself and tributaries to the creek through the project area have concentrations of total phosphorus, *E. coli*, and fecal coliform that regularly exceed the NAC Section 445A.127 standards. Restoration of Steamboat Creek is proposed as part of the SouthEast Connector Project to improve water quality and provide additional

environmental benefits. The proposed improvements have been both qualitatively and quantitatively analyzed to predict their benefit to the water quality of Steamboat Creek and its loading on the Truckee River. Again, this section of the report does not include analysis of mercury incidence or transport. The following improvements and their predicted water quality benefit are as follows:

- Stream Restoration: Bank stabilization is proposed for a length of approximately 20,000 linear feet of Steamboat Creek. Under existing conditions, the banks of Steamboat are incised and unstable throughout most of the project reach. There is extensive evidence of degradation and mass wasting. The proliferation of tall whitetop along the majority of the project reach has led to further bank destabilization. The project improvements include laying back the western bank along the majority of the project reach and significant noxious weed abatement. This will prevent mass wasting and degradation along the western side of the channel and reduce erosion into the stream channel, decreasing the amount of sediment, nutrients, and other COC loading into the stream.
- Yori Wetland Creation: The mitigation and water quality treatment wetlands located north of Pembroke and west of Steamboat Creek will be constructed to provide floodplain storage mitigation, regulatory mitigation for impacts to jurisdictional wetlands, and water quality improvement to urban drainage conveyed in Yori Drain. The wetlands will be configured in a 25-acre area north and 35-acre area south of the Yori Drain.
- Revegation: as outlined elsewhere, the restored stream banks will be vegetated with native plants and grasses. This will encourage a more robust riparian corridor and more stabilized stream banks with less erosion and mass wasting of sediment into the water column.

Analysis

Wetland Water Quality

The proposed Yori Wetlands are designed to accept flows up to 7.0 cubic feet per second (cfs), a typical flow in early spring and late summer. Flows greater than 7 cfs will be bypass the wetlands and drain to Steamboat Creek in the existing Yori Drain channel. The permanently wetted area of the proposed wetlands (obligate wetlands) occupies 18 acres with an additional acreage of facultative (seasonally wetted) wetlands comprising an additional 47 acres of wetland habitat. This additional acreage does not have an effect on the water quality treatment efficiency of the system and is not used in the calculation of the removal efficiencies. The 18 acres of obligate wetland, both north and south portions of the wetlands, have a combined flow length of 2,843 meters (m) and a water volume of 55,564 cubic meters (m^3).

The Pollutant Removal Estimates for Wetlands (PREWET) Version 2.5 screening model was used to evaluate the proposed wetland. The PREWET model was designed with the objective of estimating the Removal Efficiency for a specific pollutant by a wetland. The model is a screening-level assessment that uses simplified quantitative methods that minimize time and effort for the end-user.

The geometry of the flow pathway through the wetland and the volume of water within the wetland dictate the Hydraulic Residence Time (HRT). The HRT is used as a major variable in calculating particle settling time, nutrient rate of decay parameters, and removal efficiency of pollutants. Table 1 presents the HRT as a function of the wetland inflow. A review of NDEP water quality record provided a base flow value of 2.5 cfs. Flow rates presented below were selected to correlate with values of inflow from Yori Drain used on the Steamboat Creek water quality model.

TABLE 1
Wetland Inflow vs. Hydraulic Residence Time
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Wetland Inflow (cfs)	2.5	4.0	5.7	7.0
Hydraulic Residence Time (days)	8.76	5.47	3.84	3.13

Inflow Water Quality data were obtained from grab samples that were analyzed using U.S. Environmental Protection Agency methods at a Nevada-certified analytical laboratory. The inflow data used as model parameter inputs included total coliform (MPM), total phosphorus as P, total suspended solids (TSS), biological oxygen demand (BOD), total nitrogen (TN), and total phosphorus (TP). Values used for pollutant inflow to the Yori Drain were obtained on June 25, 2013, and reviewed against the NDEP historical monitoring statistical set and found to represent the general level of water quality impairment of Yori Drain. Table 2 presents the Yori Drain water quality data for inflow to the treatment wetland.

TABLE 2
Water Quality Input Parameters for the PreWET Model
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Parameter	Value	Units
Total Coliform (MPN)	2,419.6	/100 mL
Total Phosphorous as P	0.1	mg/L
Total Suspended Solids (TSS)	10.0	mg/L
Biochemical Oxygen Demand (BOD)	6.0	mg/L
Total Nitrogen (TN)	2.0	mg/L

The removal efficiency of the wetlands is directly related to the time the water resides in the system. Table 3 illustrates the relationship between removal efficiency for a selected parameter as a function of the inflow to the wetland.

TABLE 3
Removal Efficiency as a Function of Inflow Rate
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Hydraulic Residence Time	8.76 days	5.47 days	3.84 days	3.13 days
Wetland Inflow	2.5 cfs	4.0 cfs	5.7 cfs	7.0 cfs
Total Coliform (MPN) – percent	89	83	78	74
Total Phosphorous as P – percent	0.28	0.26	0.25	0.24
Total Suspended Solids (TSS) – percent	66	57	46	41
Biochemical Oxygen Demand (BOD) – percent	92	88	84	81
Total Nitrogen (TN) – percent	32	23	17	15

Results of the pollutant removal estimate model runs were incorporated into the Steamboat Creek water quality modeling to assess potential direct and indirect impacts of the proposed SEC project on the water quality parameters of Yori Drain, Steamboat Creek, and downstream receiving waters.

Steamboat Creek Water Quality

To analyze the current eutrophic conditions within the Steamboat Creek and investigate the potential benefits of the proposed bank stabilization and treatment wetlands, a water quality model was constructed utilizing the HEC-RAS water quality analysis capabilities. This model uses the QUICKEST-ULTIMATE explicit numerical scheme to solve the one-dimensional advection-dispersion equation. The model simulates the fate and transport of water temperature, dissolved nitrogen constituents (including nitrate, nitrite, ammonia, and organic nitrogen), dissolved phosphorus constituents (including orthophosphate and organic phosphorus), algae, carbonaceous BOD, and dissolved oxygen (USACE/HEC, 2010). This model was chosen because it is a publically available model and, because HEC-RAS is being utilized for flood analysis for the project, the required geometric data were already mostly compiled.

The water quality HEC-RAS model extends along Steamboat Creek from the southern project boundary to the confluence of the Truckee River. The existing conditions model was constructed with topography generated by Washoe County from 2006/2008 data merged with the SEC project-specific topography data. The digital elevation model (DEM) for the analysis was adjusted to include bathymetry collected by the USACE for the existing conditions Truckee Meadows HEC-RAS model completed in 2012 and some invert data that were collected for the SEC project. Proposed conditions geometry was adjusted to reflect the proposed 50 percent design. Water quality and flow data were obtained from NDEP, augmented with data collected by the U.S. Geological Survey (USGS). Meteorological data were obtained from the National Oceanic and Atmospheric Administration's National Climatic Data Center. Two flow events were run for both existing and proposed conditions: June 6, 1989, and October 5, 1989. These events were chosen because there was moderate flow in the Steamboat Creek and there was complete data for input along the project reach including Steamboat Creek at Short Lane and Pembroke, Thomas Creek at Short Lane, Rio Poco Drain upstream of Steamboat Creek, Boynton Slough upstream of Steamboat Creek, and Yori Drain upstream of Steamboat Creek. NDEP has water data into 2009-2010; however, there are little flow or water quality data for Yori Drain, one of the major inputs of nutrients into Steamboat Creek along the project reach. The data for the modeling runs were constructed as follows:

- Flow Data: flow input is based on the instantaneous flow measurements that were taken by NDEP at the same time as the water quality data samples were obtained. Because the model is being run in unsteady flow for 2.5 days for each event, flow was adjusted for diurnal fluctuation according to hourly data available from the USGS for similar flow regimes.
- Metrologic Data: the model requires atmospheric pressure, air temperature, humidity, cloudiness, and wind speed inputs. Hourly data for these inputs are available from the National Climatic Data Center by request for what was in 1989 referred to as the Reno/Cannon International Airport Met Station located at Latitude/Longitude 39.484/-119.77. Because this is close to the project area, these data were deemed appropriate. Data were obtained for both events for the entire time period.
- Water Temperature and DO: NDEP collected monthly water quality as grab samples along Steamboat Creek and the contributing ditches/creeks as outlined above from the late 1970s to 2010. The HEC-RAS water quality model requires water temperature and DO concentrations for all upstream boundary conditions. The input was taken from the NDEP data. Because the model is run in unsteady flow conditions for 2.5 days for each event, the boundary conditions for temperature and DO were adjusted to show a diurnal fluctuation according to hourly water quality data available from USGS in Steamboat Creek for similar weather conditions (the exact dates of the NDEP data are not available in the USGS data).

- Nutrient Parameters: The NDEP water quality data include nitrogen and phosphorus constituents, TSS, turbidity, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, mercury, fecal coliform, pH, and BOD. The data for the project area do not include any algal or chlorophyll information. Because the HEC-RAS model was run in unsteady state for 2.5 days for each event, the inputs were adjusted to have diurnal fluctuations set to emulate the fluctuations within the hourly water quality data available from the USGS.
- Carbonaceous BOD (CBOD): BOD data were collected by NDEP along with the other constituents. However, it is difficult to estimate the CBOD from these values. Consequently, the CBOD values for Steamboat Creek were taken from the USGS data for Steamboat Creek at Cleanwater Way, adjusted by percentage according to the BOD data in the NDEP data set for the tributaries to Steamboat Creek.
- Algae concentrations: Limited chlorophyll data are available for some time periods from the USGS at Cleanwater Way. For the SEC project, grab samples were obtained from the Steamboat Creek and Yori Drain and analyzed for total algal concentrations. These are utilized in the modeling for concentrations within Steamboat Creek. The diurnal fluctuations of the algae concentrations are based on the chlorophyll fluctuations present in the USGS hourly data. The concentrations within the tributaries other than Yori Drain are based on Yori Drain observed data.
- Because of the lack of observed data, all nutrient parameters were left as default for all model runs. No calibration was attempted.

The existing conditions water quality HEC-RAS model was run with the existing conditions Steamboat Creek channel morphology and the parameters as outlined above for both the June 1989 and October 1989 events. The proposed conditions water quality HEC-RAS model was run with the proposed Steamboat Creek channel morphology (including the laid back west bank) for both the June 1989 and October 1989 events. To simulate the proposed revegetation and willow planting along the banks for the majority of the project reach, the cloudiness factor (percentage of cloud cover) was increased for the entire simulation by 25 percent. This was done because there is no way to simulate shading in the meteorological water quality HEC-RAS input. The water quality input parameters for the Yori Drain input were adjusted according to the PreWet results as presented above.

The HEC-RAS results show that there was a slight reduction in diurnal DO fluctuations and algae concentrations throughout the study reach and a larger reduction downstream of the input of Yori Drain. Table 4 shows the results at Steamboat Creek River Station 4333, just upstream of Cleanwater Way.

TABLE 4
Water Quality Modeling Results
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Flow Event	Temperature Fluctuation (Degrees C)	DO Fluctuation (mg/L)	Maximum Algal Concentration (mg/L)
June 4–6 Existing	21.1 – 30.7	7.0 – 9.7	0.80
June 4–6 Proposed	20.9 – 30.4	7.2 – 9.4	0.78
October 4–6 Existing	11.4 – 19.8	8.1 – 10.7	0.54
October 4–6 Proposed	10.3 – 19.9	8.1 – 9.4	0.53