Memo

Stantec

To:	Garth Oksol, PE	From:	Trina Magoon, PE
	RTC		Stantec Consulting Inc.
File:	180101098	Date:	January 20, 2009

DESIGN MEMO: PLAN LINE STUDY FOR THE SOUTHEAST CONNECTOR TASK 2.1.D.3 DRAINAGE ANALYSIS

Stantec Consulting was retained by the RTC to perform a plan line study of the SouthEast Connector extending from the intersection of South Meadows Parkway and Veterans Parkway to the intersection of Greg Street and Sparks Boulevard. This plan line study is limited to the previously established Valley Corridor. The following design memorandum addresses Task 2.1.D.3, Drainage Analysis, of the subject project.

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Introduction

The proposed SouthEast Connector (SEC) traverses a floodplain its entire length. See *Figure 1 – FEMA Floodplain Map*. The United States Army Corps of Engineers (USACE) and the Truckee River Flood Project (TRFP) have been working on a comprehensive flood model for the lower Truckee Meadows area that encompasses the entire proposed SEC alignment. In order for the SEC project to comply with the proposed TRFP ordinance, the SEC cannot adversely impact the floodplain or Zone I Critical Flood Pool; specifically, it cannot raise the water surface elevation or decrease volumes in the flood area. By modifying the USACE / TRFP flood model to include the SEC and associated mitigation, Stantec has demonstrated no adverse impact to the floodplain and no adverse impact to the USACE / TRFP flood control improvements, as summarized in this technical memorandum. The flood model used by the USACE / TRFP is the USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) program Beta Version 4.0.

References and Previous Studies

The following references and previous studies provide the basis for establishing the drainage evaluation and design criteria:

- *Alignment Study Tahoe/Pyramid Link*, SEA, Incorporated, dated October 21, 1983.
- *Conceptual Design Report – Lower Steamboat Creek Bank Stabilization and Enhancement*, HDR, dated October 12, 2007.
- *The Confluence of Property Rights, Floodplain Management, Dams, Wetlands, and Levees – Legally Speaking; On Behalf of the Truckee River Flood Project Presentation,* Michael Baker Corporation, undated.
- *Flood Insurance Rate Maps (FIRM's) for Washoe County Nevada and Incorporated Areas*, Federal Emergency Management Agency, index dated June 6, 2001.
- *Flood Insurance Study (FIS) for Washoe County Nevada and Incorporated Areas*, Federal Emergency Management Agency, dated June 6, 2001.
- *Hidden Valley Project Working Group Traction Project Presentation,* HDR, dated March 5, 2008.
- *Hydrologic Criteria and Drainage Design Manual (HC&DDM)*, City of Sparks, dated February 21, 2001.
- *Hydrologic Criteria and Drainage Design Manual (HC&DDM),* Washoe County, dated October 25, 2004.
- *Interim Water Policies and Criteria*, Regional Water Planning Commission, dated February 25, 2003.
- *Major Drainageways Plan*, City of Reno, dated June 9, 1992.
- *Preliminary Alignment Evaluation for Tahoe Pyramid Link, Rio Poco to Mill Street Extension,* SEA, Incorporated, dated October 1996.
- *Public Works Design Manual*, City of Reno Department of Public Works, dated November 1, 2000, revised June 30, 2007.
- *Reno Municipal Code, RMC Article XVII: Flood Hazard Areas, Article XVIII: Wetlands and Stream Environment Protection Standards, and Article XIX: Drainage Way Protection Standards.*
- *Resolution No.* 2008-1, Flood Project Coordination Committee, dated Rev. September 19, 2007.

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- *Steamboat Creek Restoration Plan*, prepared for the Washoe-Storey Conservation District by Jeff Codega, Planning/Design, Inc., and WESTEC, Inc., dated January 15, 1998.
- *Truckee Meadows Feasibility Study - Truckee River, Nevada – Hydrology Office Report*, USACE, dated July 16, 1999.
- *Truckee Meadows Flood Control Project Attachment B – Hydraulic Design (Draft)*, Sacramento District USACE, dated January 18, 2005.
- *Truckee Meadows, Nevada – Addendum to General Re-Evaluation Report Phase F3 Milestone Conference Revised Hydrology,* Sacramento District USACE, dated January 2003.
- *Truckee River Flood Management Project – Floodplain Storage Volume Mitigation Ratio Presentation*, Truckee River Flood Project, dated January 30, 2007.
- *Truckee River Flood Project – Flood Funding Study Presentation*, Truckee River Flood Project, undated.
- *Zone 1 / Critical Flood Pool: Flood Storage Volume Mitigation Model Ordinance* (preliminary), Washoe County, City of Reno and City of Sparks, undated.

Design Criteria

Excerpts from local manuals, policies and ordinances were compiled to develop drainage and flood control design criteria for the proposed SEC Plan Line study as follows:

Washoe County / City of Sparks Hydrologic Criteria and Drainage Design Manuals (HC&DDM)

Both Washoe County and City of Sparks have similar drainage design criteria as outlined in their respective Hydrologic Criteria and Drainage Design Manuals.

- Culvert Crossings
  - Designed for the major storm event.
  - Headwater shall be 1.5 times the culvert height.
  - Adjacent properties must not be adversely affected.
- Bridge Crossings
  - 100-year design flow plus two feet of freeboard between the 100-year water surface elevation and the low chord of the bridge.
  - Additional freeboard may be required for special hydraulic conditions.
  - In Special Flood Hazard Areas (SFHA's), the bridge shall not back up the 100-year storm flow greater than 1-foot above the natural water surface elevation without mitigation measures.
  - Adjacent properties must not be adversely affected.

- THE POLICY OF WASHOE COUNTY SHALL BE TO REQUIRE CULVERT/BRIDGE CROSSINGS OF STREETS WITHIN THE FOLLOWING LIMITATIONS:

Right-Of-Way Width	Minimum Capacity (Recurrence Interval)
Major and Minor Arterial Highways Greater than or equal to 80-feet	100-Year (No Overflow)
Collector and Local Streets Less than 80-feet	100-Year (See Note)

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- Note: A dipped overflow section may be allowed by the County Engineer if the maximum velocity does not exceed 6 feet per second and the maximum depth does not exceed 0.5-feet a the street crown. As a minimum, the culvert or bridge shall pass the existing channel capacity.

- Roadway / Streets
  - Minor On-Site Storm Event (Q5)
    - Maximum velocity will be 6-feet per second.
    - Runoff in excess of street capacity shall be piped.
    - Maximum limits of street inundation:
      - Local 12-foot width dry centered
      - Collector 18-foot width dry centered
      - Arterial 48-foot width dry centered
  - Major On-Site Storm Event (Q100)
    - Contained within street ROW.
    - Maximum velocity will be 6 feet per second.
    - Maximum depth will be 1-foot at the gutter flowline.
    - Maximum limits of street inundation:
      - Local Street flooded.
      - Collector 1 lane (12-feet) dry 6 foot width dry centered.
      - Arterial 1 lane (12-feet) dry each direction 24 foot dry width centered.
  - Off-Site Minor and Major Storm Events
    - Diverted around or piped / channeled through development.
    - The construction in Special Flood Hazard Areas (SFHA's) and areas of interim delineation shall be completed in accordance with (Article 416 of Washoe County) or (Section XXXX The City of Sparks) Development Code.
    - Flows must return to the natural drainage path after exiting development.
  - Streets which intersect State Highways where local, collector or arterial streets intersect State Highways, the criteria of the Nevada Department of Transportation shall be followed for design of storm drains and inlets at said intersections.

<u>City of Reno Public Works Design Manual</u>

Following are pertinent excerpts from the *City of Reno Public Works Design Manual, Chapter II – Storm Drainage*.

Section 1. – General

- Item 3, page 200 - Discharge of storm drain waters into a major drainage facility or natural water course is not to be a contributing factor insofar as increasing the 100-year peak flow of storm drainage runoff in said drainage facility above that which exists at present; or the engineer is to provide to the City conclusive proof in the drainage report that any increase in peak flow will not adversely affect or cause damage to any property along said drainage facility or water course now or in the future, based on existing

zoning, master plan and elements thereof, and any increase to the historical flow, whichever is more restrictive.

- Item 4, page 201 – Development of property shall not adversely affect any natural major drainage facility or natural water course. Natural facilities shall remain in as near a natural state as practicable, with any modification proposed, including any erosion mitigating measures, addressed in the drainage report and drainage plan.

Section 2. – Drainage Report

- 4e. page 204 – Streets
  - Depth and velocity of flow for major and minor storms. Demonstrate that a 12-foot clear lane exists for emergency vehicles at all times.

- 5. page 204-205 – Areas within flood hazard zone when applicable:
  - Impacts
  - Protection
  - Compliance with Federal Emergency Management Agency (FEMA) requirements, RMC 12.24 "Flood Hazard Areas:, and critical flood zones.
  - Construction shall meet Truckee River Flood Pool Zone building requirements per RMC 18.12.605.

Section 3. – Design Requirements (Public and Private):

- 23. page 213
  - Drainage structures under and/or through all streets shall be designed to carry the runoff generated by the 100-year storm from fully developed conditions within the watershed, based upon maximum density and in accordance with current zoning. A 12-foot clear lane shall be provided for emergency vehicles at all times.
- 27. page 214
  - Embankment shall not be placed within the 100-year floodplain of a major drainage facility without prior approval by the City Engineer. Where such approval is given, the embankment shall be faced with riprap sized for velocity to a minimum of 1-foot above the 100-year flood line. Development within areas shown on the Flood Insurance Rate Map (FIRM) shall comply with Chapter 12.24 of the Reno Municipal Code.
- 31. page 214
  - Any work which requires fill intended to be placed within the "waters of the State of Nevada" shall receive permission from the State Department of Environmental Protection prior to beginning construction. The City of Reno shall receive a copy of this permission prior to issuance of any permit.

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Regional Water Planning Commission (RWPC) 2004 – 2025 Washoe County Comprehensive Regional Water Management Plan

Chapter 1 – Regional Water Planning Policies and Criteria

- Goal 3: Plan for the Protection of Human Health, Property, Water Quality, and the Environment through Regional Flood Plain and Storm Water Management
  - Policy 3.1.b – Flood Plain Storage within the Truckee River Watershed
    - The local flood management staff shall evaluate impacts using qualitative or quantitative analyses and the evaluation may be uncomplicated and brief. If a more in-depth analysis is appropriate, the following "tiered" approach and criteria shall be used:
      - Current ordinance requires that a project not increase the 100-year peak flow at the boundary of the property. If the project can also demonstrate no increase in volume of the 100-year runoff at the boundary of the property, the analysis is complete.
      - If there is an increase in 100-year volume of runoff at the boundary of the property, the project may demonstrate that either:
        - The increase in volume of runoff will have no adverse impact to downstream properties and no adverse impact to hydrologically connected properties, or
        - The increase in volume of runoff will be mitigated in a regional project without adverse impact to hydrologically connected and downstream properties. (Until a storage mitigation plan is in place with respect to this paragraph, no flood plain storage mitigation will be required.)
      - Impacts of a proposed project will be evaluated by comparing conditions without the proposed project (current conditions) and conditions with the proposed project.
      - Impacts of a proposed land use change will be evaluated by comparing conditions without the proposed land use change (current conditions) and conditions with the build out of the reasonable development potential of the proposed land use change.
    - The watershed is divided into four zones with different project size thresholds for the purposes of review:
      - Zone 1: Critical Flood Pool – all proposed land use changes and proposed projects will be reviewed for their impact on hydrologically connected and downstream properties.

Flood Project Coordination Committee Resolution No. 2008-1

A resolution proposing principles and guidelines to be used as a basis for adoption of local ordinances for floodplain storage mitigation within Critical Flood Zone 1.

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Whereas:

- The Flood Project Coordinating Committee was established by the Truckee River Flood Management Project Cooperative Agreement dated April 12, 2005 by and between Washoe County, the cities of Reno and Sparks, and the University of Nevada, in part for the purpose of providing direction for the Truckee River Flood Management Project;
- The Regional Water Planning Commission has identified and designated the Critical Flood Zone 1 as an area where flood waters could temporarily flow or accumulate during food events. This Flood Project Coordinating Committee finds and determines that the placement of fill or the construction of improvements in said Critical Flood Zone 1 in a manner that could restrict the flow of or displace the temporary accumulation of flood waters could increase the elevation flood waters thereby increasing the possibility of loss of life, could force flood waters onto other properties thereby causing or increasing the damage to those other properties, and could diminish the effectiveness of flood control facilities being built by the Truckee River Flood Management Project. As a result, the Flood Project Coordinating Committee desires to propose principles and guidelines to be used as a basis for adoption of local ordinances for floodplain storage mitigation in the Critical Flood Zone 1 in the interest of public safety, health and general welfare of citizens and protecting properties in Washoe County; and
- Local ordinances should require that any grading or construction activities in the Critical Flood Zone 1 be completed in such a way as to avoid adverse impact on flood water elevation in such zone;

Now therefore, be it resolved by this Committee:

- Preamble
    - This Committee urges all member jurisdictions to enact or amend land use ordinances and regulations to embody the following principles with respect to Displacing Projects.
- Section 1 Mitigation Required for Displacing Projects.
    - All Displacing Projects should meet the following requirements:
        - Stormwater discharges from the Displacing Project should be limited to pre-development conditions relative to peak flows; and
        - Provide flood storage volume mitigation to achieve No Adverse impact.
- Section 2 Mitigation Methods and Requirements.
    - The mitigation requirements established in Section 1 may be met by:
        - Causing one unit of Mitigation storage Volume for every one unit of floodplain storage volume that is displaced. The Mitigation Storage Volume must occur within:
            - the same Flood Storage Area as the volume displaced; and
            - at the same Elevation Band as the volume displaced; or
        - If Mitigation Storage Volume is proposed to be outside the same Flood Storage Area or the same Elevation Band, then the mitigation within the Critical Flood Zone 1 must:

- cause one unit of Mitigation Storage Volume for every one unit of floodplain storage volume displaced, and
- demonstrate No Adverse Impact through application of the Truckee River Flood Project Mitigation Model.

- The entire amount of Mitigation Storage Volume must be available for flood storage before any flood event. Detention basins required by other ordinances are not eligible to be counted as Mitigation Storage Volume for this ordinance.
- Mitigation cannot occur in conflict with and/or at the same location of approved Truckee River Flood Project features as indicated on maps on file in the Truckee River Flood Management Office.
- Mitigation must occur concurrently with or prior to a reduction of flood storage volume.

- Section 3. Definitions.

  - Critical Flood Zone 1 means that area depicted as Zone 1 in the Truckee Meadows Floodplain Storage Zones Map, figure 1-2 of the Regional Water Plan dated January 2004.
  - Displacing Projects means any proposed public or private construction which changes existing grades, imports fill, and/or displaces any volume of flood water in Critical Flood Zone 1 below the water surface indicated on the Elevation Map.
  - Elevation Band means the bands depicted in the Elevation Map.
  - Elevation Map means the latest version of the Truckee River Flood Management Project's Ground Elevation and Flood Water Elevation Map Series adopted and administered and updated from time to time pursuant to a cooperative agreement between all jurisdictions who have adopted a version of this proposed legislation. A copy of the Elevation Map will be kept on the Truckee River Flood Management Project website.
  - Flood Storage Area means those areas designated on the Elevation Map. If construction or mitigation is to occur in an area that is not designated as a Flood Storage Area on the Elevation Map, then mitigation must occur as provided in Section 2 of this Resolution.
  - Mitigation Storage Volume means flood storage volume provided in Critical Flood Zone 1 to offset a displacement of flood water volume as a result of construction activity.
  - No Adverse Impact means no increase of the water surface elevation on the Elevation Map within Critical Flood Zone 1.
  - Truckee River Flood Project Mitigation Model means a hydraulic model as updated from time to time, adopted and administered pursuant to a cooperative agreement between all jurisdictions who have adopted a version of this proposed legislation. Until such a cooperative agreement is reached, the HEC – RAS Version 4.0 model prepared by the United States Army Corps of Engineers shall be used.

<u>Truckee River Flood Project Additional Criteria</u>

The freeboard requirement for the SouthEast Connector Bridge Crossing at the Truckee River will be a minimum of 4-feet over the 117-year water surface elevation at each overbank to accommodate a 20-year wind/wave event.

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Hydrology

Onsite Hydrologic Analyses

Onsite hydrologic analyses will be prepared during the preliminary design phase and will be based upon the City of Reno's Public Works Design Manual, Washoe County and the City of Sparks' Hydrologic Criteria and Drainage Design Manual's (HC&DDM's) and will comply with all local ordinances. These analyses will utilize the Rational Method to estimate 5-year and 100-year peak flow rates along the length of the roadway project. Onsite peak flow rates will be used to size onsite drainage infrastructure, including curb and gutter, catch basins and storm drains and roadside ditches. As well, alternatives will be evaluated to mitigate the increase in peak flow rates due to the increase in impervious surfaces.

Offsite Hydrologic Analyses

Hydrographs for the Truckee River Flood Project / USACE Truckee River HEC-RAS Unsteady State Model were developed by the USACE and are based upon statistical analyses of Truckee River watershed gauge data, upstream reservoir operating data, as well as the Flood of 1997 as a pattern.

The USACE developed hypothetical hydrographs for the local watershed between the Reno and Vista gages for the Boynton Slough, Steamboat Creek at Huffaker Hills, Steamboat Creek at its confluence with the Truckee River, the North Truckee Drain, and the contributing area to the Truckee River below the North Truckee Drain.

Details of the USACE hydrologic analyses can be found in the *Truckee Meadows Flood Control Project Attachment B – Hydraulic Design (Draft) and Truckee Meadows, Nevada – Addendum to General Re-Evaluation Report Phase F3 Milestone Conference Revised Hydrology* reports. The hydrographs included with the HEC-RAS Unsteady state models were used without modification for both existing and proposed conditions.

Hydraulic Modeling

Onsite Hydraulic Analysis

Onsite hydraulic analyses and design of roadway storm drain infrastructure will be prepared with the preliminary design phase and will comply with all local ordinances.

Offsite Hydraulic Analyses

Models Used

Existing and proposed conditions models of the Truckee Meadows have been prepared by the US Army Corps of Engineers utilizing their HEC-RAS River Analysis System program Beta Version 4.0. The models, provided to Stantec by the USACE, that will be used to model the proposed SouthEast Connector include:

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- 117-Year Event Existing Conditions
  - Without Truckee River Flood Project
  - Without Lower Steamboat Creek Restoration Project.
- 117-Year Event Proposed Conditions
  - With Truckee River Flood Project
  - With Lower Steamboat Creek Restoration Project (as modified by Stantec)

The models above have been modified to include the SouthEast Connector:

- 117-Year Event Existing Conditions
  - Without Truckee River Flood Project
  - Without Lower Steamboat Creek Restoration Project
  - With SouthEast Connector
  - With 1:1 Volume Mitigation
- 117-Year Event Proposed Conditions
  - With Truckee River Flood Project
  - With Lower Steamboat Creek Restoration Project (as modified by Stantec)
  - With SouthEast Connector
  - With 1:1 Volume Mitigation

Methodology and Model Modifications

HEC-RAS, the computational model used for the hydraulic analysis, uses different elements to describe the natural topography and flood characteristics. The two main elements used to describe the landform geometry in the lower Truckee Meadows are:

- Cross Sections – represent the geometric boundary of the stream, and
- Storage Areas – represent lake like regions in which water can be diverted into and/or from.

Figure 2 – SouthEast Connector Drainage and Flood Control Modeling, shows the layout of cross sections for streams in the lower Truckee Meadows area including portions of the Truckee River, Steamboat Creek, North Truckee Drain, Boynton Slough and storage areas such as the UNR Farms, Rosewood Lakes and North Butler Ranch areas. This figure also shows the preliminary alignments and the proposed alignment of the SEC, *RTC 34-40,* as shown in green.

Figure 3 – SouthEast Connector Drainage and Flood Control Modeling Sparks Boulevard to Mira Loma Drive and *Figure 4 – SouthEast Connector Drainage and Flood Control Modeling Mira Loma Drive to South Meadows Parkway* are larger scale project regions with water surface elevation comparisons at key locations for the proposed TRFP, with and without the SEC.

Figures 5 and 6 SouthEast Connector Drainage Cross Section / Storage Areas show representative cross sections along the length of the SEC alignment, identifying the main channel conveyance areas, storage areas, proposed roadway location and proposed Steamboat Creek volume mitigation / restoration.

A short length of the proposed SEC alignment traverses cross section areas while the majority traverses storage areas. Modeling modifications to cross sections involve adding points to the cross section to represent the roadway fill (Fills) and utilizing the Channel Design / Modification

function to perform a series of trapezoidal cuts (Cuts) into the existing channel geometry to create a new channel geometry that represents the Steamboat Creek Volume Mitigation/ Restoration. The Cuts and Fills are evaluated to ensure a 1:1 volume ratio is maintained and there is no net loss of floodplain storage.

Storage areas are modified by dividing a given storage area in two along the roadway alignment, thereby creating two new storage areas, one on each side of the alignment. Storage area volumes are then recalculated and applied to the newly created storage areas. Storage area connections, including weir and culvert data are added in a trial and error fashion until equalization of water surface elevations are obtained on either side of the roadway alignment. Storage area connections used for this analysis include primarily culverts, but could be modified to bridge sections for long stretches to reduce costs, enhance aesthetics and provide better wildlife migration. As well, connections at key locations have been set with a minimum 8-foot clearance to provide for pedestrian path crossings.

The following steps were used to interface the approved USACE Triangulated Irregular Network (TIN) and HEC-RAS models with ESRI's GIS program ArcMap, version 9.2. First, the HEC-GeoRAS plug-in to ArcMap was used to extract the HEC-RAS geometry consisting of the following relevant project elements: storage areas, cross sections, river reaches, and river banks. Precision editing tools within the ArcMap environment were then used to modify stream reaches and storage areas. Using the USACE TIN and the 3D Analyst plug-in to ArcMap, new volumes for the modified storage areas were calculated at specific elevation intervals. HEC-GeoRAS tools were then used to prepare a HEC-RAS import file containing the newly modified geometry. This newly modified geometry data was then imported to the appropriate HEC-RAS model using a HEC-RAS import tool and the model was updated accordingly. Finally, the elevation interval results produced by the 3D Analyst plug-in were manually entered into the HEC-RAS model.

Alignments

Given the alignment alternatives within the alignment corridor, the proposed improvements would all be similar in nature and cost. All alignments require conveyance structures (bridges/culverts) to convey streamflows through the roadway or provide equalization of flood water volumes and elevations within the flood pools (storage areas). As well, all flood volume lost in the placement of fill for the road must be mitigated at a 1:1 ratio. This has been accomplished by modifications to the Steamboat Creek that will facilitate future restoration efforts.

Proposed Flood Control Infrastructure and Mitigation

Proposed flood control infrastructure has been sized at stream and roadway crossings to convey the peak flow rate associated with the flooding source and are in accordance with the Design Criteria outlined above. Table 1 below, identifies the preliminary sizes and types of facilities by location.

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Table 1 – Proposed Flood Control Infrastructure

Location	Type	# Barrels	Size
Truckee River	Bridge	0	1230' span
Truckee River Alternative	Bridge w/ RCB's	54	12' x 8' plus 530' span
Clean Water Way	ConSpan or RCB	1	36' x 16'
Pembroke Drive	none		
Boynton Slough	RCB	3	16' x 8'
Mira Loma Drive	ConSpan or RCB	4	14' x 8'
Huffaker Narrows	ConSpan or RCB	10	14' x 8'
Equalization Culverts (Zone 1 Critical Flood Pool)	RCB RCB RCB	43 10 49	12' x 8' 12' x 7' 12' x 6'

The proposed infrastructure shown in Table 1 should be further evaluated during the preliminary design phase to identify potential economic and aesthetic benefits. Some long stretches of box culverts, for example, could potentially be replaced by a bridge section as illustrated above at the *Truckee River* and *Truckee River Alternative* locations.

SouthEast Connector Volume Mitigation / Steamboat Creek Restoration

One main criterion for development within the Zone 1 Critical Flood Pool is to maintain a 1:1 volume ratio for any development located within the flood pool. This requirement was accomplished by widening and or relocating portions of the Steamboat Creek.

The typical roadway section is approximately 92 feet wide across at the pavement section, has 6:1 side slopes and varies on average between 3 and 20 feet tall. The height of the roadway is based upon roadway crossing elevation and geometry, bridge freeboard criteria and maintaining a minimum 12-foot dry lane (in each direction) during a major storm event (117-year). Typical roadway sections within each reach were evaluated for volume of fill displaced within the flood pool and preliminary channel sections were developed for Steamboat Creek Restoration and Volume Mitigation. Modified channel sections were then refined to ensure the 1:1 volume ratio was met.

The proposed channel was preliminarily located adjacent to the roadway with a simplified geometry. The location and geometry of any realigned portion of Steamboat Creek should be further evaluated during the preliminary design phase to ensure the proposed modifications can be incorporated into a full restoration design that will improve the health and stability of the creek.

Modeling Results

The proposed conditions HEC-RAS models that include the SEC as well as the proposed Steamboat Creek Volume Mitigation / Restoration, result in water surface elevations that are lower than the proposed conditions HEC-RAS models without the aforementioned proposed improvements. Figure 3 – SouthEast Connector Drainage and Flood Control Modeling Sparks Boulevard to Mira Loma Drive and Figure 4 – SouthEast Connector Drainage and Flood Control Modeling Mira Loma Drive to South Meadows Parkway illustrate the location of the recommended SEC alignment, cross section locations. These figures, along with Table 2 below,

illustrate the differences in water surface elevation and storage area volume for affected or nearby storage areas.

Table 2 - Water Surface Elevations by Storage Area Comparisons

Storage Area	Proposed USACE HEC-RAS Model without SouthEast Connector (117YR_PR)			Proposed USACE HEC-RAS Model with SouthEast Connector and Steamboat Creek Volume Mitigation (117YR_PR_SEC)		
	Water Surface Elevation (ft.)	Storage Area Minimum Elevation (ft.)	Storage Area Volume (ac-ft.)	Water Surface Elevation (ft.)	Storage Area Minimum Elevation (ft.)	Storage Area Volume (ac-ft.)
Area 4	4393.50	4393.50	0.00	4393.50	4393.50	0.00
Area 5	4396.81	4370.00	828.53	4396.76	4370.00	661.06
Area 5B	4396.75	4383.00	84.91	4396.69	4383.00	84.35
Area 5C	-	-	-	4396.75	4370.00	162.70
Area 6	4396.93	4383.90	1500.35	4396.87	4383.90	958.19
Area 6B	-	-	-	4396.87	4383.90	491.04
Area 7	4396.98	4381.10	1927.32	4396.93	4381.10	1908.87
Area 8	4396.98	4388.30	471.55	4396.92	4388.30	462.60
Area 9	4396.98	4387.50	483.86	4396.92	4387.50	477.31
Area 10	4396.97	4379.90	1779.86	4396.91	4379.90	1395.57
Area 10B	-	-	-	4396.90	4379.90	334.36
Area 11	4396.99	4385.50	223.86	4396.92	4385.50	209.82
Area 11B	-	-	-	4396.92	4385.50	7.14
Area 12	4396.99	4385.50	314.05	4396.93	4385.50	307.34
Area 23	4396.99	4387.70	79.13	4396.93	4387.70	76.13
Area 24	4397.01	4387.50	580.04	4396.93	4387.50	501.17
Area 24B	-	-	-	4396.95	4387.50	61.07
Area 25	4396.99	4386.00	418.88	4396.92	4386.00	150.78
Area 25B	-	-	-	4396.93	4386.00	252..59
Area 26	4396.30	4388.10	41.18	4396.30	4388.10	41.16
Area 28	4388.44	4384.70	29.55	4388.41	4384.70	29.37
Area 29	4388.44	4383.10	121.98	4388.42	4383.10	118.81
Area 41	4390.06	4388.60	21.47	4390.06	4388.60	21.42
Area 42	4396.96	4391.70	35.88	4396.89	4391.70	31.67
Area 43	4382.80	4382.80	0.00	4382.80	4382.80	0.00

Table 2 illustrates that the water surface elevations for all storage areas are the same or lower under proposed conditions with the SouthEast Connector and Steamboat Creek Volume Mitigation. As well, a comparison of all cross sections resulted in a slight lowering of water surface elevations within the revised area.

Table 2 also illustrates that the storage area volumes decrease under proposed conditions with the SouthEast Connector and Steamboat Creek Volume Mitigation. The decrease in storage area volume due to the inclusion of the SouthEast Connector fill has been offset by the increase in volume in the cross sectional areas of Steamboat Creek, thereby ensuring the 1:1 volume

mitigation has been met. Other slight differences in storage area volume can be attributed to the lower Water Surface Elevation (WSEL) and using a newer surface model (triangulated irregular network, or TIN) to sample storage area volumes, than the USACE had originally used in their modeling effort.

Near the confluence of the Truckee River and Steamboat Creek, the FEMA 100-year WSEL is approximately 4395.5 and the USACE/TRFP 117-year WSEL is approximately 4396.9 (with USACE project and without the SouthEast Connector project). The USACE WSEL is therefore approximately 1.4 feet higher than the FEMA WSEL in an area that averages approximately 8-feet to 9-feet deep. The increase in depth between the USACE and FEMA WSEL's, in this area, amounts to approximately 16%.

Currently, the total volume of fill that will be placed within the Zone 1 Critical Flood Pool is approximately 870,000 cubic yards (CY). This represents approximately 4% of the total volume of the Zone 1 Critical Flood Pool (excluding the Huffaker Detention Facility area), which is roughly estimated at 20,000,000 CY. A one to one (1:1) volume mitigation ratio has been used to balance the fill placed in the floodplain with the excavation or cut taken out of the floodplain within reaches of the Steamboat Creek.

Future refinements to the roadway alignment, profile, and cross sectional geometry should be evaluated further during preliminary and final design to ensure all flood control and drainage design criteria are met.

Comparisons to Previous Studies

The *Alignment Study Tahoe Pyramid Link*, prepared by SEA, Incorporated, dated October 21, 1983 provided the first effort to identify major drainage infrastructure for the proposed SouthEast Connector alignment. The 1983 report proposed rechannelization of a majority of the Steamboat Creek from the Huffaker Narrows to the Truckee River as well as Reinforced Concrete Box (RCB) culvert crossings for the major drainages crossed by the then proposed alignment. The effect of the alignment on the Truckee River and Steamboat Creek flood pool as well as at drainage structures was evaluated for backwater effects using USACE's computer program HEC-2. Although three alternatives were evaluated in the 1983 report for the Truckee River crossing, only one resulted in no net increase in water surface elevation of the Truckee River and associated flood pool, and therefore the other alternative crossings have not been shown here.

REFERENCE: PLAN LINE STUDY FOR THE SOUTHEAST CONNECTOR TASK 2.1.D.3 DRAINAGE ANALYSIS

Table 3 below lists the proposed 1983 infrastructure:

Table 3 – 1983 Alignment Study Proposed Flood Control Infrastructure

Location	Type	# Barrels	Size	Q100 (cfs)
Truckee River	Bridge (viaduct) Bridge (crossing)	n/a	1000' span 300' span	19900
Clean Water Way (Kimlick Ln.)	*			7500
Pembroke Drive	RCB	5	10' x 12'	
Mira Loma Drive	RCB	5	10' x 12'	5700
Huffaker Narrows	RCB	6	10' x 12'	5700
Steamboat Creek (south of Huffaker Narrows)	RCB	6	10' x 12'	5400

*Included in the Truckee River Bridge crossing.

The subsequent *Preliminary Alignment Evaluation for Tahoe Pyramid Link, Rio Poco to Mill Street Extension,* SEA, Incorporated, dated October 1996 briefly commented on the impact to the Waters of the US, wetlands and streams, but did not specifically re-assess the impacts to the flood pool or provide an update for flood control improvements or associated costs.

The preferred alignment results in less of an impact to Waters of the US (WOUS), wetlands and streams than reported in the previous 1983 and 1996 reports. Proposed infrastructure requirements have increased, but can be directly attributed to complying with newer regulations and coordination with the USACE\TRFMP Truckee River Flood Project.

Coordination / Client Concerns

Stantec has coordinated the drainage component of the SouthEast Connector Plan line study with the Cities of Reno and Sparks, Washoe County, the Truckee River Flood Management Project and the USACE. Stantec made two presentations to the TRFP, one face to face meeting with the USACE where the USACE concurred with Stantec's analysis methodology, and numerous phone and email correspondence with the USACE, Cities and County. As well, the drainage analyses and proposed improvements have been presented in front of two public meetings and two RTC Board meetings.

A Conceptual Recreation Plan was prepared by Stantec Consulting for the TRFP that includes a conceptual design for recreation elements within the proposed Huffaker Detention Regional Park. The SouthEast Connector alignment in this area is constrained at the southern end of the proposed park at the intersection of South Meadows Parkway and Veterans Parkway and at the northern end of the park by the location and alignment of the proposed dam associated with the Detention Facility as well as culturally significant sites that must be avoided. Given the northerly and southerly constraints, the distance between them and the desired speed limits, the proposed alignment will likely be located in the middle of the proposed park. Design elements and improvements for the SouthEast Connector in this reach include elevating the roadway above the 100-year water surface elevation impounded by the proposed dam, roadway geometrics that align with the crest of the dam and conveyance structures under the roadway fill to equalize flood volumes within the ponded areas behind the dam. Coordination with the TRFP is ongoing

to mitigate the impacts of the SouthEast Connector alignment to the proposed recreation facilities within the park.

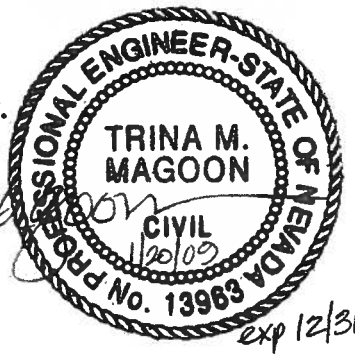
The reports, *Steamboat Creek Restoration Plan*, prepared for the Washoe-Storey Conservation District by Jeff Codega, Planning/Design, Inc., and WESTEC, Inc., dated January 15, 1998 and *Conceptual Design Report – Lower Steamboat Creek Bank Stabilization and Enhancement*, HDR, dated October 12, 2007 identify proposed restoration requirements and alternatives for various reaches of Steamboat Creek. One criterion for the SouthEast Connector is to maintain a 1:1 volume mitigation ratio for fill placed within the Zone 1 Critical Flood Pool, which provides an opportunity for both the SouthEast Connector project and the Steamboat Creek Restoration by utilizing the volume of fill removed for the Steamboat Creek restoration for the SouthEast Connector mitigation. For this phase of the project, generalized proposed channel cross sectional cut areas were developed along the Steamboat Creek to closely match the adjacent SouthEast Connector fill areas. Further design elements for the Steamboat Creek Restoration will be evaluated and incorporated into future phases of design for the SouthEast Connector.

Coordination with the local communities, the TRFP and the USACE Sacramento District should be maintained throughout the project. As well, during the preliminary design phase, additional coordination should be made with the USACE Reno Field Office, Nevada Division of Environmental Protection (NDEP), Nevada Department of Wildlife (NDOW), Nevada Division of State Lands, United States Fish and Wildlife Service, the Natural Resources Conservation Service (NRCS) and other interested parties.

Conclusions

This technical memorandum demonstrates that with the appropriate mitigation measures the SouthEast Connector project will not adversely impact the existing floodplain. Stantec has modified the USACE HEC-RAS models of the Truckee River Flood Project, in a fashion agreeable to the USACE, to test mitigation measures in the form of bridges, box culverts, and one to one (1:1) volume mitigation. The results of our analyses show that the proposed SouthEast Connector will have no adverse impact to the Truckee River Flood Project, water surface elevations or volumes in Critical Flood Zone 1 and will be in compliance with, or exceed, all local ordinances.

STANTEC CONSULTING, INC.



Trina Magoon, PE
Associate, Water Resources

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