TECHNICAL MEMORANDUM

To: Agnes Martelet, Environmental Compliance Manager, City of Carmel

From: Dudek and Waterways Consulting, Inc.

Prepared by: Matt Weld, PE and Dudek (Permit Requirements)

Date: February 14, 2019

Re: Mission Trail Stream Stability Assessment

INTRODUCTION

The goal of this memorandum is to summarize methodology, results, and recommendations of our work performed in response to the City of Carmel's request for a stream stability survey within the Mission Trail Nature Preserve (Preserve). Specifically, the City requested the completion of the following tasks:

- Determine factors contributing to instability, as evidenced where steep channel banks are failing, the channel bed is incising, and high flows are utilizing downstream roads and trails instead of the stream course.
- Evaluate the stability of access and drainage improvements (e.g., gabion baskets, bridge
 crossings, wet ford crossing, culverts, and trails within the riparian corridor) to determine
 which are stable and which may need some sort of adjustment to address drainage-related
 concerns.
- Recommend actions to stabilize the stream and enhance overall habitat conditions in the riparian corridor.
- Identify anticipated permitting requirement associated with proposed maintenance, repairs or enhancements.

Work was performed by Waterways Consulting, Inc. (Waterways) and Dudek during the months of July through November of 2018.

The Preserve is located near the southeastern edge of the city of Carmel-by-the Sea. The 34-acre property was acquired by the City in the 1970s and was designated a nature park in 1979 by the Carmel City Council. A Master Plan for the Preserve was adopted by the City in the mid-1990s that sets forth goals and policies for long-term preservation and use of the Preserve. The southern edge of the Preserve fronts Rio Road and extends north into the wooded neighborhoods of Carmel near the Highway 1 corridor. The narrow, linear property is surrounded by improved residential properties within the City and unincorporated County areas. The Preserve is accessed from four signed trailheads and has a number of trails through the property.

Two main perennial drainages and several smaller drainages transect the Preserve. The main perennial drainage enters the Preserve at its northern end, runs along its western boundary and forks near the center of the Preserve. Another perennial drainage feeds into the Preserve from the east. The Preserve supports a mix of vegetation types.

METHODOLOGY

Background Data Review

Past Studies reviewed to inform our assessment included:

- Mission Trail Nature Preserve Master Plan
- Drainage Investigation for the Mission Fields Area of Carmel Valley Summary Report (Nolte & Associates, 1986)
- Baseline Biological Assessment, Mission Trail Nature Preserve (Nedeff, 2016)
- Preliminary Soil Investigation for Storm Water Detention Pond (Neill Engineers, Inc., 1984)
- Carmel General Plan/Local Coastal Program (2004)

Topographic mapping and utility layers were also provided by the City in GIS format for review and incorporation into our study.

Visual Site Assessment and Meetings with Project Advisory Committee

The project was initiated with a kickoff meeting on July 9th, 2018, attended by Waterways, Dudek, Nicole Nedeff, and City Staff. The meeting focused on discussion of project goals and objectives, available resources, and scheduling.

An introductory site walk was attended on July 27th to review existing conditions. This walk was again attended by Dudek, Waterways, Nicole Nedeff, a representative of Friends of the Mission Trail Nature Preserve, and City staff. During this walk, the group walked the length of the Preserve and discussed known points of concern.

Waterways returned to visit the site on numerous occasions during and after mapping to hike the park perimeter and adjacent streets as design and analysis progressed.

A final site visit to the lower end of the Preserve was performed on October 25th and was attended by Waterways, Dudek, Nicole Nedeff, and City Environmental Compliance Manager Agnes Martelet. The purpose of this meeting was to review preliminary design drawings in the vicinity of the Preserve entrance at Rio Road.

Topographic Mapping

Topographic mapping was performed by Waterways staff on five separate dates in July and August 2018, using a combination of RTK GPS and total station equipment. Elevation Datum is NAVD 88. The horizontal datum is NAD83 California State Plane, Zone 3. Control was established using the Leica Geosystems Smartnet Global Navigation Satellite System (GNSS) Network. Our survey included a long profile of the primary channel, periodic cross sections, and topographic mapping at select areas where drainage concerns were most apparent. Our work was overlain onto watershed scale topography 2010 LiDAR survey provided by the City (AMBAG, 2010).

Long Profile Survey

The long profile survey extended from Rio Road to the upstream limit of the Preserve. Points were surveyed at cross sections, at significant grade breaks, and on prominent features such as grade

controls, weirs, or culverts. The profile is presented on Sheet C2 of the Attachment A, with stationing that corresponds to the site overview on Sheet C1.

Notable features on the profile include the following:

- Shallow channel in vicinity of stations 6+00 to 8+00, where flooding has been observed.
- Channel incision below the confluence at approximately Station 22+25
- Distinct break in channel profile at the station 22+25, where average channel gradient changes from approximately 1.4% to 7%.
- High number of constructed grade control elements (over 20) between Station 22+50 and upstream limit of Preserve, ad distance of approximately 1600 feet.

Cross Section Survey

Cross sections were surveyed periodically through the Preserve at representative locations or where features relevant to the study were observed. Twenty cross sections are presented on Sheets C9 through C11. Sheet C8 shows the cross section locations overlain onto the Preserve overview map.

Beginning at cross section A and extending through cross section I, there is clearly a broad flat floodplain available to the channel. However, it appears as if the channel has been relocated to the east side of the floodplain, hugging the toe of the slope. Cross sections C through F demonstrate that the channel is no longer occupying the lowest point in the floodplain, which appears to be well to the west of the current alignment. Channel realignment to the valley margins was a common management technique in the past, often used to optimize floodplains for ranching or farming, allowing uninterrupted access and improved opportunities to dry floodplains in early spring. The result appears to be a channel with an unnaturally straight planform and entrenched condition, offering reduced floodplain function.

Detailed Site Survey Maps

Detailed topographic maps were prepared to allow for development of higher resolution site plans at areas where erosion, sedimentation, or flooding problems were evident, or where potential projects were discussed during our site meetings. The following areas were mapped in greater detail, and area shown on Sheets C3 through C6 of Attachment A.

- 1. Tributary Crossing and Trail Junction
- 2. Concrete Ford and Trail Re-route Site
- 3. Bridges at Confluence

These sheets also provide preliminary repair recommendations, as described further below.

Hydrologic Assessment

A rainfall-runoff simulation model was prepared to allow us to analyze the project site hydrology during design storm events. The purpose of this modeling was to determine approximate runoff rates that would support hydraulic analysis of erosive forces, floodplain interaction, and hydraulic capacity at individual locations. The model was developed in sufficient detail for the purposes of this study, but should still be considered approximate since it did not include a calibration effort or a comprehensive mapping of the watershed outside the park boundaries, especially where located on private property.

These efforts would be considered outside the scope of the current study, but may be warranted in support of the final design of certain scenarios.

Mapping Sources

Our analysis was based on several different mapping resources. General watershed topography was provided by the City of Carmel in the form of a digital terrain model resulting from a LiDAR survey (AMBAG, 2010). Within the park boundaries, dense vegetation rendered the LiDAR mapping unreliable, so we used our own field observations and topographic data collection. Outside the park, drainage paths were determined by walking and/or driving the city and county streets and Caltrans right of way to visually inspect surface flow splits and pipe alignments where topography alone was not sufficiently detailed to accurately determine watershed or subwatershed boundaries. Outfall locations and approximate subwatershed boundaries were also provided by the City of Carmel and Monterey Resources Agency on large format maps included within Appendix 3. Figure 1A within Appendix 1 shows the resulting stormwater basin map with subwatersheds and junctions labeled.

Analysis

The contributing sub-basin drainage areas were evaluated using the Santa Barbara Urban Hydrology (SBUH) method in Autodesk® Storm and Sanitary Analysis 2016 (SSA) as follows:

- U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) Type 1A 24-hour storm events for Pebble Beach were used.
- Hydrologic soil types were determined from the USDA Natural Resources Conservation Service (NRCS) Web Soil Survey (see Appendix 1-B for NRCS Hydrologic Soil Report).
- Weighted average runoff curve number (CN) values were determined using the hydrologic soil type and percent type of cover as shown in Table 1, Appendix 1-C.
- Time of concentration was calculated in SSA using the SCS TR-55 method, see SSA reports in Appendix 1-D. Minimum time of concentration was set at 5 minutes.
- Area 1 (Basin CAR-10b) and Area 2 (Basin CAR-10a) were evaluated separately from each other to facilitate pipe sizing for future routing for each basin. Their combined flow was also evaluated for analysis of improvement downstream of these basins.

The pipes and channels were modeled as follows:

- Kinematic Wave link routing.
- Hazen-Williams force main equation.
- Pipes were modeled as concrete with a Manning's n value of 0.015.
- The open channel was modeled with a Manning's roughness of 0.04 for boulder steps in the upstream section and 0.025 for straight gravel beds in the downstream sections.
- The existing pipe system in Basin CAR-8 starts with a 24" pipe at the intersection of Ocean Avenue, Junipero Avenue, and Mountain View Avenue. After two blocks the pipe upsizes to a 36" pipe for another two blocks before upsizing to a 42" pipe prior to reaching the outfall. Initial modeling revealed that the existing 24" portion of the pipe system is undersized. This is resulted in a surcharge of the catch basin at the intersection and a net loss from the initial model due to overland flow. This reduced downstream flows in the primary channel located within the Preserve. According to the City, this pipe will eventually be upsized to prevent

- overland flow. As a result, the existing 24" portion of the pipe was modeled as a future 36" pipe. The existing 36" and 42" portions of the system were below capacity during the 100-year storm so they were modeled as they exist today.
- Existing pipe inverts and slopes were assumed based on LIDAR surface topography to facilitate analysis of the stormwater flows in the creek. Any future upgrades to the existing pipe system in Basin CAR-8 should evaluate the system with measured inverts and slopes to ensure an accurate analysis of energy and hydraulic grade lines within the pipe system.

Results

Peak flows for the 2, 10, 50, and 100-year recurrence interval storms were calculated at points of interest or subwatershed boundaries and are provided within Table 1.

TABLE 1: Hydrology Study Results

	Storm Event Peak flow (cfs)				
Point of Interest	2-year	10-year	50-year	100-year	
A (Upstream End of Project)	6.09	27.71	42.09	46.36	
B (Station 22+00)	8.04	35.8	54.39	59.91	
C (Tributary @Confluence, Sta 22+25)	27.02	97.31	142.13	155.30	
D (Proposed Bridge, Sta 12+00)	30.65	117.23	174.08	190.87	
E (culvert at Rio Rd)	31.28	124.10	186.31	204.81	
Area 1 (Tributary from West, Sta 8+00)	0.22	2.05	4.24	4.95	
Area 2 (existing culvert under Serra Trail, Sta 2+00)	0.18	1.22	1.95	2.16	

Hydraulic Assessment

The results of the hydrologic assessment were used to provide preliminary design geometry for proposed pipes and channels, as well as to evaluate the approximate capacity of the existing channel at representative locations. Calculations are provided in Appendix 3 that show the approximate capacity of the existing channel, just before flows overtop channel banks and access floodplains. Analysis was performed using Manning's equation applied at individual cross sections of interest that were surveyed by Waterways. Hydraulic roughness (Manning's "n") values were assigned at each location based on observations, photographs, and engineering judgement. Channel slope was estimated from the long profile survey. Results of the analysis are provided in Table 2.

Most locations appear to have less than 10-year capacity. Most notably, cross section M (where sandbags are being used to contain floodwaters) can only pass 55% of the 10-year event before overtopping its banks. Cross section K shows the capacity of a typical gabion weir, roughly four feet wide by 1 foot deep at the crest. Again, the capacity is only 64% of a 10-year storm peak. Many of these weirs are failing due to flanking, largely the result of this undersized geometry.

Cross Section A shows that the channel near the downstream end of the park has a capacity in excess of the 10-year event. Localized flooding that has been observed in this area is likely due to tributary drainages coming from Area 1 and Area 2.

Our analysis did not extend outside the park to include downstream storm drains. Backwater effects of undersized downstream conveyance structures, if present, may influence this result.

TABLE 2: Hydraulic Modeling Results

Cross Section ID/ Station	Description	Channel Capacity at Top	Calculated Peak Flow (cfs) for Varying Return Periods		
ib/ Station		of Bank (cfs)	Q10	Q 50	Q ₁₀₀
	VEGETATED EARTH SWALE TYPICAL OF				
A (3+21)	CONDITIONS WITHIN DOWNSTREAM	122	117.2	174.1	190.9
	REACH OF PARK				
	VEGETATED EARTH SWALE LOCATED		117.2	174.1	190.9
D (10+73)	DOWNSTREAM OF CONCRETE FORD.	82			
	CHANNEL ALIGNEMENT AT TOE OF	02			
	HILLSLOPE				
	VEGETATED CHANNEL INCISED ALONG				
G (16+82)	ROAD WHERE TREES ARE THREATENED BY	112	97.3	142.1	155.3
	BANK EROSION				
K (23+19)	CREST OF GABION WEIR	23	35.8	54.4	59.9
	CONSTRICTED CROSS SECTION NEAR				
M (25+54)	RESIDENCE WITH SANDBAGS ON RIGHT	20	35.8	54.4	59.9
	BANK (SANDBAGS NOT MODELED)				

CONCEPT LEVEL TREATMENT RECOMENDATIONS

Preliminary treatment recommendations are presented at a concept level for project sites selected based on observed conditions, modeling results, or input received during meetings with the project advisory committee. These concept level designs have been overlain on the topographic basemaps or cross section surveys for review. The designs have been developed sufficiently to review existing conditions and evaluate opportunities and constraints to repair alternatives. Additional mapping, analysis, and design effort would be required to provide plans at a detail suitable for permit applications or implementation. The project schedule did not allow the site to be reviewed during winter conditions. As a result, we may have missed some areas of concern, especially where the channel gradient is low and the floodplain is relatively flat within the downstream reaches of the project.

Potential projects are presented below, from downstream to upstream.

Site #1 - Park Entrance at Rio (Sheets C3and C3A)

The park entrance is reported to experience local flooding during winter months. At present, runoff enters this area from four sources, including two roadside ditches that run along the service road (Serra Trail), an asphalt swale discharging from Rio Way, and as ponded or sheet runoff from the depressed

area to the north of the Serra Trail. The area is drained by an 18 inch culvert that starts on the north side of the road and discharges to a shallow and discontinuous grass lined swale that eventually meets with Mission Creek. The inlet elevation of the culvert and the shallow grade of the swale are very near the grade of the road, and do not take advantage of the available fall to the creek bed. As a result, the area is poorly drained.

Proposed repairs should seek to alleviate ponding on the road surface with a minimal amount of disturbance to the adjacent wetland or riparian areas. Further, the preferred option should not significantly lower local groundwater elevations.

We have presented two alternative solutions. Each alternative includes raising the access road by approximately 6 inches, over a distance of roughly 650 feet. This may not seem like a significant change, but it would greatly reduce ponding and saturation of the roads surface without damaging adjacent sensitive areas, and would minimize ongoing maintenance requirements at ditches.

The additional actions recommended under each of the two alternatives are influenced by a proposed drainage realignment further upstream within the Preserve, as shown in Sheet C4. As a result of actions shown on C4, additional drainage will be entering the area to the west of the Serra Trail near the Preserve entrance, where flooding is already a concern.

Alternative 1 (Sheet C3) would install a new drop inlet and 24 inch diameter culvert to convey these flows under the Serra Trail. Beginning at the culvert outlet, a newly excavated wetland swale would convey runoff to the creek. The swale would be excavated deeper than the current ditch line to take better advantage of the available fall to the creek. Although the initial construction of the swale would require removal of several small oak trees, the final project would result in a net increase in wet meadow. The swale construction would also necessitate relocation of a concrete slab and bench and two signs. The raised road surface would continue through the park entrance gate to allow for improved conveyance of street drainage to minimize ponding on the path.

Alternative 2 (Sheet C3A) varies in that it would use a subsurface pipe to convey flows from the new drop inlet at the west side of the Serra Trail. A second inlet would capture ditch flow from the north as it flows along the east side of the Serra Trail. The pipe alignment would be constructed below the existing path that heads east toward the creek, avoiding impacts to adjacent natural areas. Local grades would necessitate slightly raising the path to provide adequate cover for the pipe. A more detailed study would be required to guarantee the feasibility of this alternative as there is limited fall available from the west side of the Serra Trail to the creek invert. The pipe's outlet would need to be placed very near to the channel bed, introducing the risk of backwater effects or plugging with sediment.

A third alternative (not drawn) would raise the trail surface and asphalt approach, and would replace the culvert beneath the trail, but would not address drainage to the east. This alternative would address nuisance flooding associated with street runoff by replacing the existing asphalt water bar with a more functional drain directing flows off of the trail. The alternative would improve capacity for high flows to cross under the trail within the new culvert, allowing for Project #3 to proceed as described below. The drawback to this approach is that the trail section from the entrance to the creek (near the bridge) may still experience flooding during larger storms. There may be an opportunity to also raise this section of

trail slightly, but additional survey would be required to ensure that doing so would not block drainage from the north.

<u>Site #2 - Pedestrian Boardwalk (Sheets C1 & C7)</u>

Near station 6+50, an existing unimproved trail crosses the low point of the valley in an area that is reported to experience occasional flooding under existing conditions. This flooding would be exacerbated by the actions shown on sheet C4. We recommend installation of a raised boardwalk here to provide improved year round access and minimize the environmental footprint of the Preserve's access paths. A profile of the proposed boardwalk is shown on Sheet C7. The required length would be approximately 120 lf. Installation of a boardwalk would benefit year-round pedestrian access, but would limit vehicular access and require modification of existing maintenance techniques. If vehicular access is required at this location, an alternative means of access improvement can be explored.

Site #3 - Tributary Crossing and Trail Junction (Sheet C4)

Sheet C4 shows a confluence of trails along the western side of the valley bottom, where a tributary drainage from the west is causing erosion and sedimentation of various trail segments. High sediment loads from outside the Preserve are currently routed down a ditch in an easterly direction and then settling out along the west side of the Serra Trail, where the profile flattens. The result has been flooding of the Serra Trail due to ditch blockages, as well as erosion of the ditch leading to the Serra Trail.

The proposed repair would consist of rerouting the drainage to the South, where it can dissipate and deposit sediment within the valley low to the west of the Serra Trail, ultimately crossing the Serra Trail near the Preserve entrance. The feasibility of this approach would need to be confirmed by additional topographic mapping within the densely vegetated area west of the Serra Trail. However, several cross sections already surveyed here show this as a promising alternative that could provide flow attenuation and sediment storage opportunities with low maintenance requirements.

Where the drainage crosses the path at the west edge of the valley, either a culvert or a concrete ford would be recommended. Either approach would need to extend somewhat up the slope to capture runoff before it hits the road shoulder. This area is at the head of an alluvial fan and may otherwise avulse and miss the pipe or ford inlet.

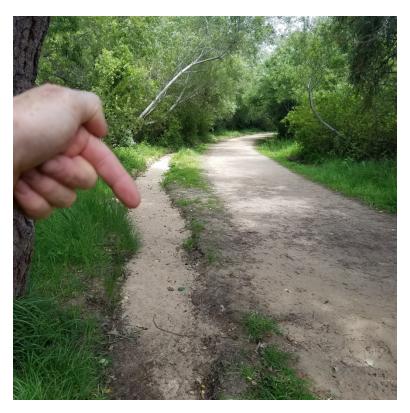


Photo 1: Sedimentation of ditch near station 8+00

Site #4 - Concrete Ford and Trail Re-route Site (Sheet C5)

Sheet C5 shows an area where several trails meet. Two separate concerns are addressed with the proposed repairs. The first concern is that an existing concrete ford was constructed over a larger than necessary footprint within the channel and the downstream end has become exposed by incision processes. The downstream half of the structure no longer appears necessary and can be removed to allow the natural stream channel to be restored. Demolition of the portion of the ford would require installation of a concrete cutoff wall at the point of demolition and construction of a "roughened channel" composed of boulders, cobble, gravel and fines) to transition to the downstream channel profile.

Removal of the concrete ford would discourage foot travel along the left bank of the channel just downstream of the ford, where the creek bank is denuded and eroding due to foot traffic along a narrow and unsafe section of trail. At present, the trail traverses along the top of bank immediately adjacent to the channel for approximately 75 feet before climbing up the eastern slope of the valley. The result has been degradation of the stream bank and local vegetation.

The second component of the work would be to decommission and restore this section of trail and reroute the alignment across a pedestrian bridge and through a redwood grove where benches have been placed. This trail realignment presents an opportunity to route pedestrians through a unique portion of the Preserve that is less sensitive to disturbance than the current path along the streambanks.



Photo #2: Looking upstream at Site #4, Concrete Ford.

Site #5 - Bank Erosion along Serra Trail (Sheets C1 and C7)

Bank erosion and channel incision were observed along a straight reach of channel between station 14+00 and station 21+00. AS can be seen from the profile on Sheet C2, the channel has started to climb somewhat at this location and has become slightly entrenched relative to the floodplain. The channel has begun to undermine trees along the road shoulder, as shown in photo #3 below.

The channel will continue to incise and further erode the banks if left untreated in this location, ultimately undermining the Serra Trail. Meanwhile, sediment storage and floodplain functions are diminished by the entrenched condition that prevents floods from accessing the floodplain. Erosive forces are magnified by the straightened planform and deepened cross section, which increases shear and velocity over natural conditions.

Sheet C1 shows the potential to realign the channel here to provide a little more breathing room and establish a profile and cross section that better connects floodwaters to the floodplain. Sheet C7 shows a typical cross section within this reach. Note that the valley low point is well to the west of the current channel alignment, as a sign that the channel alignment is likely artificially straightened here.



Photo 3: Looking in southerly direction along Serra Trail. Note creek immediately adjacent to the road and trees beginning to fail into creek as a result of channel incision and bank erosion.

A realigned channel could be constructed with a much smaller cross section, allowing more regular inundation of the floodplain, improved groundwater recharge, sediment storage, and flood attenuation. Trees along the current channel alignment would be protected, and future channel bank maintenance requirements would be greatly minimized. Additional mapping would be required to ensure there would be no unanticipated consequences from reintroducing flows to the floodplain, such as unwanted flooding downstream or risk to infrastructure or mature native riparian trees within the proposed alignment. The alignment shown is schematic and subject to revision pending further analysis.

If further analysis and design prove this option to be infeasible, another variant would be to raise the existing channel in place to achieve similar effects. Raising the channel could be accomplished by constructing intermittent raised riffle sections and by breaching the right bank to allow better access to the floodplain. Existing trees along the banks could be buttressed and protected in place with fill.

Site #6 - Bridge Replacement and Headcut Mitigation at Confluence (Sheet C6)

Sheet C6 depicts the confluence of the main channel with a primary tributary from the west, near the end of 11th Avenue. As seen best on the long profile (Sheet C2), this is the location with the valley profile transitions from relatively flat slope averaging 1.4% to a steeper slope averaging 7%. A large headcut (knick-point) of six to eight feet in height is migrating upstream and currently arrested at station 22+40, just below the bridge on the main channel. The headcut has already progressed up the western tributary to the location of a bridge crossing that currently acts as grade control. The bridge is undersized for the design flow of 97.6 cfs, and causes a constriction that currently exacerbates erosion

and channel instability in this area. The narrow opening is further at risk of plugging and causing more damage. Channel banks downstream of the two bridges and beyond the confluence are overly steepened from recent incision, despite past efforts to stabilize the channel with rock.

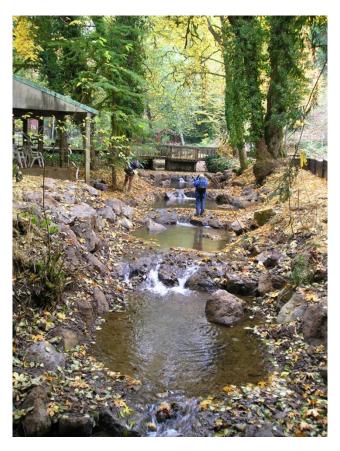


Photo 4: Example of boulder weirs used to raise a channel profile to support an existing bridge (Murtaugh Creek, OR)

Stabilization of this area may need to extend one hundred feet or more downstream of the confluence in order to create a stable channel profile that prevents the headcut from migrating further upstream and destabilize the bridge, channel banks, or upstream improvements. Stabilization could be accomplished by replacing the bridge over the western tributary, laying back steep channel banks that are currently eroding, revegetating the area, and establishing grade control for the channel profile through weirs or a fully reconstructed channel, as shown.

The Preserve boundary limits are unclear within this area. A boundary survey is recommended here to better define opportunities and constraints.

Site #7 - Flooding at Station 25+50

One location within the upstream reaches of the Preserve (approx. station 25+50) shows evidence of recent flooding, based on the presence of sandbags along the right bank of the channel opposite a residence (Photo 5). At cross section M, shown on Sheet C10, one can clearly see the undersized channel cross section area available for flood conveyance. As noted above, the channel capacity here is

only approximately 55% of the 10-year flood peak. The profile (Sheet C2) shows that the area of concern is immediately upstream of a gabion weir with a height of nearly 4 ft. The likely solution here would require locally lowering and/or widening the channel to accommodate high flows, possibly modifying or removing the existing gabion grade control. This action may require installation of a structural wall or rock slope protection to preserve the yard and/or path. The location of the Preserve boundary is uncertain in this vicinity. The entire channel may be located on private property.



Photo 5: Looking west across channel at flood-prone area (station 25+50)

Site #8 - Headcuts in upper reaches (Existing conditions shown on Sheet C2)

The reach upstream of the confluence with the western tributary is characterized by steep valley walls and a highly confined channel at a very uniform average slope of 7%, with dozens of constructed grade control structures and debris jams forming drops of varying heights. Bank failures were apparent in many areas due to channel incision and subsequent widening, though the channel appears to have been temporarily arrested at the current profile. Though many of the existing drop structures are undersized, poorly constructed, or in disrepair, they are working together to provide hydraulic roughness and energy dissipation, as well as a physical structure to maintain the current profile grade.

The existing weirs are primarily composed of stone, timber, or gabion baskets, of varying geometry. Only the gabion weirs – of which there were over ten located- appear to have been installed under a coordinated effort, with a relatively uniform design approach. However, these weirs are nearly all undersized and showing signs of failure. The typical failure mode is by flanking, due to their undersized

geometry (Photo 6, below). For instance, the ten year flow at this location, a flow commonly used to size such features, is approximately 40 cfs. A weir crest opening would need to be 3 feet wide at the base, with a depth of 2 feet to contain this flow, assuming 1h:1v side slopes. Many of the weirs were less than half this size.



Photo 6: Looking Upstream at a failing gabion weir with a spillway that is undersized for even moderate storm events.

Though we mapped a profile through each structure, the analysis of each weir was beyond the resources of this study. Further, it is uncertain where the Preserve boundary crosses the channel at many locations along this upper reach. We recommend that the City perform a boundary survey and determine land ownership within this reach before making further plans to stabilize the channel. Eventually, the existing weirs will fail and landowners will individually begin to experience related bank erosion, sometimes threatening structures. A comprehensive approach to monitoring and, if necessary, stabilizing the reach would benefit all.

Options for stabilization could include reconstructing weirs as they fail or proactively installing additional grade control structures between existing weirs. Natural approaches such as log weirs have been used with some success, but generally don't provide the same level of protection as stone, masonry, concrete, or similar hard structures. Gabions are a very desirable short term solution, if properly designed and installed. Benefits include their ease of installation at sites with access constraints and the

ability for hand labor crews to construct them. The primary drawback to gabions is the fact that they typically do not last more than 40 years in a stream environment.

REGULATORY – PERMITTING REQUIREMENTS

Permit Requirements and Environmental Issues

The goal of the project recommendations is to implement measures to stabilize the existing perennial stream, reduce erosion and sedimentation and to enhance overall habitat conditions in the riparian corridor along the stream, consistent with goals and policies in the Preserve Master Plan and recommendations in the Baseline Biological Assessment (Nedeff, 2016). The conceptual recommendations include eight repair measures that could be implemented at separate times and/or in combination, two of which would require additional survey and study for feasibility. Federal, state and local permits and approvals are anticipated to be required for most of the recommended activities. An overview of required permits is provided in the following section. Anticipated required permits and key issues for each recommended repair are summarized on Table 3.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (Corps) exercises regulatory jurisdiction over certain activities within waters of the United States. The Corps receives its statutory authority from Section 404 of the Clean Water Act, which regulates placement of dredged or fill material in jurisdictional waters of the United States, and Section 10 of the Rivers and Harbors Act of 1899, which regulates the construction of any structure in or over any navigable water of the United States or any work affecting the course, location, condition, or capacity of such waters. Some of the recommended repairs involve the placement of fill material within non-navigable waters¹ of the United States associated with work in stream channels.

General permits are authorizations that are issued for a category or categories of activities that are similar in nature and do not cause more than minimal individual and cumulative adverse environmental effects. Nationwide Permits (NWPs) are a type of general permit issued by the Corps. Multiple NWPs could potentially be used to authorize the work needed to implement the recommendations in this report, including NWP 13, Bank Stabilization; NWP 27, Aquatic Habitat Restoration, Enhancement, and Establishment Activities; NWP 31, Maintenance of Existing Flood Control Facilities; NWP 42, Recreational Facilities; and NWP 46, Discharges in Ditches. The various work components could potentially be viewed as separate single and complete projects, each qualifying for a separate NWP authorization. If the work is considered one single and complete project, and multiple NWPs are used, the acreage loss of waters of the United States must not exceed the acreage limit of the NWP with the highest specified acreage limit, which is 1 acre for a NWP 46; NWP 42 has a limit of 0.5 acre. NWP 13 and 27 do not have a specified acreage limit.

¹ According to federal regulations, "navigable" waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.

TABLE 3. Summary of Recommendations and Potential Permit Requirements

December ded Dece	Anticipated Permit					
Recommended Repair			RWQCB	CDP	- Issues	
1. Park Entrance – Raise Road				х	Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality	
Alt 1 – Swale and new drop inlet	х	х	х	Х	 Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality Minor tree removal Wetland enhancement 	
Alt 2- Subsurface drain and new inlets	х	х	Х	х	Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality	
2. Pedestrian Boardwalk					Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality	
Reroute existing drainage with new culvert	х	х	Х	х	Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality	
4. Removal of concrete ford and decommission and restore existing trail segment and reroute trail with new pedestrian bridge	Х	х	х	Х	Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality	
5. Channel Realignment	х	х	Х	Х	Additional mapping required Avoid/minimize riparian habitat impacts	
 Bridge Replacement over tributary, channel bank bio- remediation 	х	х	х	Х	Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality Cultural resources review may be necessary	
7. Channel modification	х	х	Х	Х	 Not known if in Preserve boundaries NWP 31 potentially applicable if channel flood control activities have been previously authorized by the Corps. 	
Upstream bank failures and existing weir failures – further study recommended					 Bio-engineered approaches are preferred by regulatory agencies No specific recommendations at this time except for further survey work to determine potential options 	

DATA REQUIRED: For all activities requiring permits and associated notification to the Corps, an application must be submitted, using standard ENG Form 4345. The application must include a complete description of the proposed activity including necessary drawings or plans; the location, purpose and need for the proposed activity; scheduling; the names and addresses of adjoining property owners; the location and dimensions of adjacent structures; and a list of authorizations required by other federal, state, or local agencies.

RELATED LAWS

- Endangered Species Act: If a project may affect federally listed species or their critical habitat, consultation with U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) will be required. One federally-listed plant species has been identified at the Preserve: Yadon's rein orchid (*Piperia yadonii*). The City as the applicant would need to provide the Corps with a Biological Assessment (BA) or biological technical report identifying and analyzing the potential impacts to listed species. The Corps will initiate and conduct the Section 7 consultation.
- Section 401 Water Quality Certification: Water quality certifications are required for projects that require federal permits. The proposed Project will need to obtain the required certification from the California Central Coast Regional Water Quality Control Board (RWQCB) before the Corps can issue the 404 permit.
- Historic Properties: If the proposed activity would involve any property listed or eligible for listing in the National Register of Historic Places, consultation with the State Historic Preservation Officer will be required. The applicant would need to provide the Corps with a cultural resources report identifying and analyzing the potential effects to potential historic resources, e.g., structures that are over 45 years old. The Corps will initiate and conduct the consultation.

FEES: Local government agencies are not required to pay any fee in connection with permits.

Regional Water Quality Control Board

The California State Water Resources Control Board (SWRCB) oversees the policy objectives of the nine Regional Water Quality Control Boards (RWQCBs). The RWQCBs exercise jurisdiction over water quality in waters of the United States within their respective regions and administer Section 401 Water Quality Certification and Section 402 National Pollutant Discharge Elimination System (NPDES) permits pursuant to the Clean Water Act to ensure projects meet state water quality standards to regulate point source discharges of pollutants to waters of the United States. The RWQCBs also regulate impacts to waters of the state, including point-source and diffused-source discharges to land and groundwater, under California's Porter-Cologne Water Quality Control Act.

A Section 401 Water Quality Certification from the Central Coast RWQCB, Region 3 is anticipated to be necessary for the proposed improvements. Section 401 of the Clean Water Act requires any applicant for a federal license or permit to conduct any activity that may result in a discharge of a pollutant into waters of the United States to obtain a certification from the State in which the discharge originates or would originate, that the discharge will comply with the applicable effluent limitations and water quality standards. The RWQCB protects all waters in its regulatory scope, but has special responsibility for wetlands, riparian areas, and headwaters because these water bodies have high resource value, are vulnerable to filling, and are not systematically protected by other programs. Basin-level analysis focuses on pollutant removal, floodwater retention, and habitat connectivity.

DATA REQUIRED: Issuance of a Section 401 Certification requires information demonstrating the project will comply with state water quality standards and aquatic resources protection requirements. A Section 401 permit application should include information including a detailed project description, discussion of avoidance and minimization of impacts to waters of the state, impacts analysis, discussion of beneficial uses, identification of pollutants of concern and short- and long-term best management practices (BMPs) to minimize discharge of pollutants, and all associated figures (vicinity maps, project site maps, construction cross-sections, and others).

ANALYSIS REQUIRED: Analysis by the RWQCB is intended to authorize and regulate discharges into waters of the United States and waters of the State. The RWQCB will evaluate the Project's potential impacts on aquatic resources and ensure the applicant has demonstrated that: 1) a sequence of actions has been taken to first avoid, then to minimize, and lastly compensate (if required) for adverse impacts to waters of the state; 2) the potential impacts will not contribute to a net loss of the overall abundance, diversity, and condition of aquatic resources in a watershed; 3) the discharge of dredged or fill material will not violate water quality standards and will be consistent with all applicable water quality control plans and policies for water quality control; and 4) the discharge of dredged or fill material will not cause or contribute to significant degradation of waters of the State.

FEES: RWQCB fees are determined based on acreage of fill and excavation impacts within waters of the United States and waters of the State.

California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) regulates impacts to rivers, streams, and lakes in California. Fish and Game Code Section 1602 requires notification to CDFW prior to commencing any activity that may: substantially divert or obstruct the natural flow of any river, stream or lake; substantially change or use any material from the bed, channel or bank of any river, stream, or lake; or deposit debris, waste or other materials that could pass into any river, stream, or lake. The waters included in the definition of a river, stream or lake include those that are episodic as well as those that are perennial. This includes ephemeral streams, desert washes, and watercourses with a subsurface flow.

A Section 1602 Lake or Streambed Alteration Agreement (LSA Agreement) is anticipated to be required for the project due to work within CDFW's jurisdiction which could substantially adversely affect an existing fish or wildlife resource. CDFW will include measures in the LSA Agreement to protect fish and wildlife resources including administrative measures, avoidance and minimization measures, and reporting measures.

DATA REQUIRED: The LSA Agreement application should include a project description, discussion of avoidance and minimization of impacts, a wetland delineation, impacts to sensitive plants and wildlife, a copy of the CEQA document, the application filing/processing fee, all associated figures (vicinity maps, project site map, construction/grading cross sections, mitigation area, etc.), and copies of the wetlands permit application submitted to the Corps and RWQCB.

ANALYSIS REQUIRED: Analysis by CDFW is required when it determines the activity may substantially adversely affect existing fish or wildlife resources. The LSA Agreement includes measures necessary to protect existing fish and wildlife resources. Negotiation with CDFW may include CDFW staff suggesting project modifications that would eliminate or reduce harmful impacts to fish and wildlife resources. Documentation of compliance with CEQA is required before CDFW can issue a LSA Agreement.

FEES: CDFW fees are determined based on the cost of Project work within CDFW jurisdiction.

RELATED LAWS

California Endangered Species Act:Take of species listed as endangered, threatened, candidate, threatened, endangered (or state rare in the case of plants), may be authorized by CDFW under Section 2081(b) of the California Fish and Game Code if that take is incidental to otherwise lawful activities and if certain conditions are met. No state-listed species have been identified at the Preserve; two California species of special concern have been identified: Monterey dusky-footed woodrat and past observations of Monarch butterfly winter roosts.

Coastal Development Permit

A 5-year permit for park maintenance and management activities was approved by the California Coastal Commission (CCC) in 1997 to implement recommendations of the Master Plan. The primary maintenance activities included removal of invasive vegetation; trail consolidation or extension; and stream channel maintenance involving removal of obstructions to natural stream flow and placement of very limited rock slope protection (rip-rap) to reduce erosion.

The City's Local Coastal Program (LCP) was certified in 2004, which gave the City has authority to issue a Coastal Development Permit (CDP) for private or public projects within the City's coastal zone. The Mission Trail Nature Preserve Master Plan was incorporated into the City's General Plan/LCP. In 2016, the City approved a CDP for a five-year, renewable CDP for maintenance work in the Preserve in accordance with the Mission Trail Nature Preserve Master Plan. The CDP provides authorization for regular maintenance activities such as road clearance, hazardous tree removal, mowing and trail maintenance, as well as invasive species removal. The scope of the CDP also includes stream bank repair and removal of debris or fallen trees in stream channels as needed.

Most of the Preserve is identified as an "environmentally sensitive habitat area" (ESHA), including the following: Monterey pine forest; central coast arroyo willow riparian forest; coastal terrace prairie; wet meadow; and known occurrences of special-status plant and wildlife species, including Monterey dusky footed woodrat, which is a state and/or federal species of special concern (Carmel-by-the-Sea, June 2003).

Preliminary discussions with City Community Planning and Building Department staff indicate that the City would be responsible for issuing a CDP for recommended projects. Once the recommendations are finalized, they can be reviewed with the City's Community Planning and Building Department to determine if any actions would fall under the existing 5-year CDP that authorizes specified maintenance

activities, although it appears that most recommendations would not fall under the scope of regular maintenance activities.

Permitting Strategy

The permitting process can be streamlined if projects can be grouped together in one application. Design plans will be needed for all of the required permit applications. The first step would be to coordinate and facilitate agency pre-application consultation. The ACOE holds monthly inter-agency pre-application meetings and invites federal and state agencies, including CDFW and RWQCB. This meeting provides an initial opportunity to review the project with the agencies and understand agency concerns and/or permit requirements, so they are addressed in the permit application package. It also allows ACOE staff and other relevant agencies to provide direction on important project elements, such as methods and timing of work, avoidance and minimization measures, and other construction and post-construction Best Management Practices. The City would then be in the position to develop Project materials that address these concerns in advance to aid in streamlining agency review and processing of the applications.

IMPLEMENTATION AND PRELIMINARY CONSIDERATIONS FOR PRIORITIZATION

Project implementation order may be influenced by numerous factors, including but not limited to project benefits, implementation and maintenance budgets, permit considerations, land ownership, or risk. The following observations are provided for consideration and discussion.

- Projects #1 and #3 are low risk, and are straightforward in terms of design, permitting, and implementation. However, Project #3 should not proceed without Project #1. The flows routed from the realigned tributary drainage at Project #3 would otherwise exacerbate flooding in the area of Project #1.
- Project #2 provides seasonal access improvements, but is not "necessary" given that there are
 alternate access routes and this project could be considered lower priority. However,
 implementation of Project #3 would worsen existing conditions at Site #2 if project #2 was not
 implemented. In the absence of this improvement, seasonal closures of this informal trail could
 be implemented.
- Project #4 can be considered a stand-alone project. Design and implementation should be straightforward. This project is not dependent on any other projects. Delaying this project would not introduce significant additional risk. Removal of a portion of the concrete ford and restoration of the creek would be a positive habitat/resource enhancement. Project #4 includes cast in place concrete and structural work, and it may be advantageous to combine with Site #6.
- Project #5 is a stand-alone project. Delayed implementation of #5 may lead to loss of a few
 existing mature trees and/or additional maintenance or repairs to the adjacent road. The
 feasibility of this project should be verified with additional topographic and tree location surveys
 to evaluate re-alignment options to minimize/avoid riparian habitat and construction-related
 impacts. Given the scale, permitting and mitigation requirements could be more complex for
 this project than the other recommendations. If a preferable alignment is not identified near the

- proposed location shown, in-place enhancements such as riffle-augmentation (i.e., raise channel in place) may be preferable.
- Project #6 is expensive and relatively complex, but is important to prevent ongoing channel incision, bank erosion, and potential failure of the existing bridge. Thus, this one of the most critical projects.
- The relative priority of Project #7 is difficult to determine without an accurate boundary survey. This project appears relatively simple to design and implement, but may be entirely outside the City's ownership and would primarily benefit the adjacent private property.
- The grade control features located within the upstream reach identified as Site #8 are in varying levels of disrepair. The long profile survey identified over fifteen individual constructed grade control structures. As these structures degrade, the channel will continue to erode. Ideally, this reach should be treated as a whole, based on the outcome of a detailed study that evaluates risk to adjacent homes. This is a complex project that may require a longer planning schedule. Aside from the discontinuity at site #6, the profile within this reach is a relatively straight grade. We did not observe one site that presented itself as a higher priority in need of immediate attention.

Preliminary Recommendations for Project Implementation Sequencing

Based on our understanding of opportunities and constraints and the City's expressed goals, we have provided the following preliminary recommendations for implementation order. We have divided the projects into two general categories based on whether they primarily provide maintenance or risk reduction versus ecological restoration or park enhancement. Several of the projects (e.g., project 3) address both risk reduction and restoration or enhancement goals.

Table 4: Risk Reduction and Repair Projects

PRIORITY	PROJECT SITE	FACTORS INFLUENCING RANKING
1	1	SIGNIFICANT FUNCTIONAL IMPROVEMENT TO HIGH USE AREA. PROJECT IS REQUIRED IN ORDER TO IMPLEMENT #3. RELATIVELY LOW COST AND EASE OF PERMITTING.
2	3	REDUCES MAINTENANCE REQUIREMENTS AND IMPROVES FUNCTIONALITY OF TRAIL/ROAD. PROVIDES ECOLOGICAL ENHANCEMENTS IN ADDITION TO REDUCED MAINTENANCE. LOW COST AND EASE OF PERMITTING.
3	6	PROJECT PROVIDES SIGNIFICANT RISK REDUCTION AGAINST FUTURE EROSION, BUT COMES AT HIGH COST. THERE REMAINS UNCERTAINTY REGARDING LAND OWNERSHIP.
4	8	PROJECT PROVIDES GREAT BENEFITS AND RISK REDUCTION, BUT THERE IS A SIGNIFICANT AMOUNT OF PLANNING AND COORDINATION REQUIRED GIVEN THE MULTIPLE LAND OWNERS INVOLVED.

Table 5: Restoration and Enhancement Projects

RECOMMENDED IMPLEMENTATION ORDER	PROJECT SITE	FACTORS INFLUENCING RANKING
1	5	Appears to provide greatest ecological benefit and is time-dependent due to threat to existing trees.
2	4	Provides significant ecological benefits as well as functional, safety, and aesthetic improvements. Project is not time-dependent since the damage here has already been done.
3	2	Provides recreational enhancement and possibly some ecological improvements, but not to the extent of other projects.

PROJECT COSTS

Preliminary Engineer's Construction Cost Estimates are provided below in Table 6. Since project designs have only been developed to a concept level of detail, these estimates should be considered to represent "order of magnitude" values. Estimates are based on the scope and details reflected in the concept designs, and reflect our experience on recently completed projects of similar scale and complexity. The prices do not reflect cost savings that might be realized if individual projects were grouped to reduce mobilization, administrative, and related costs. The prices assume prevailing wage. Actual costs may vary considerably, given the significant number of unknowns at the concept level.

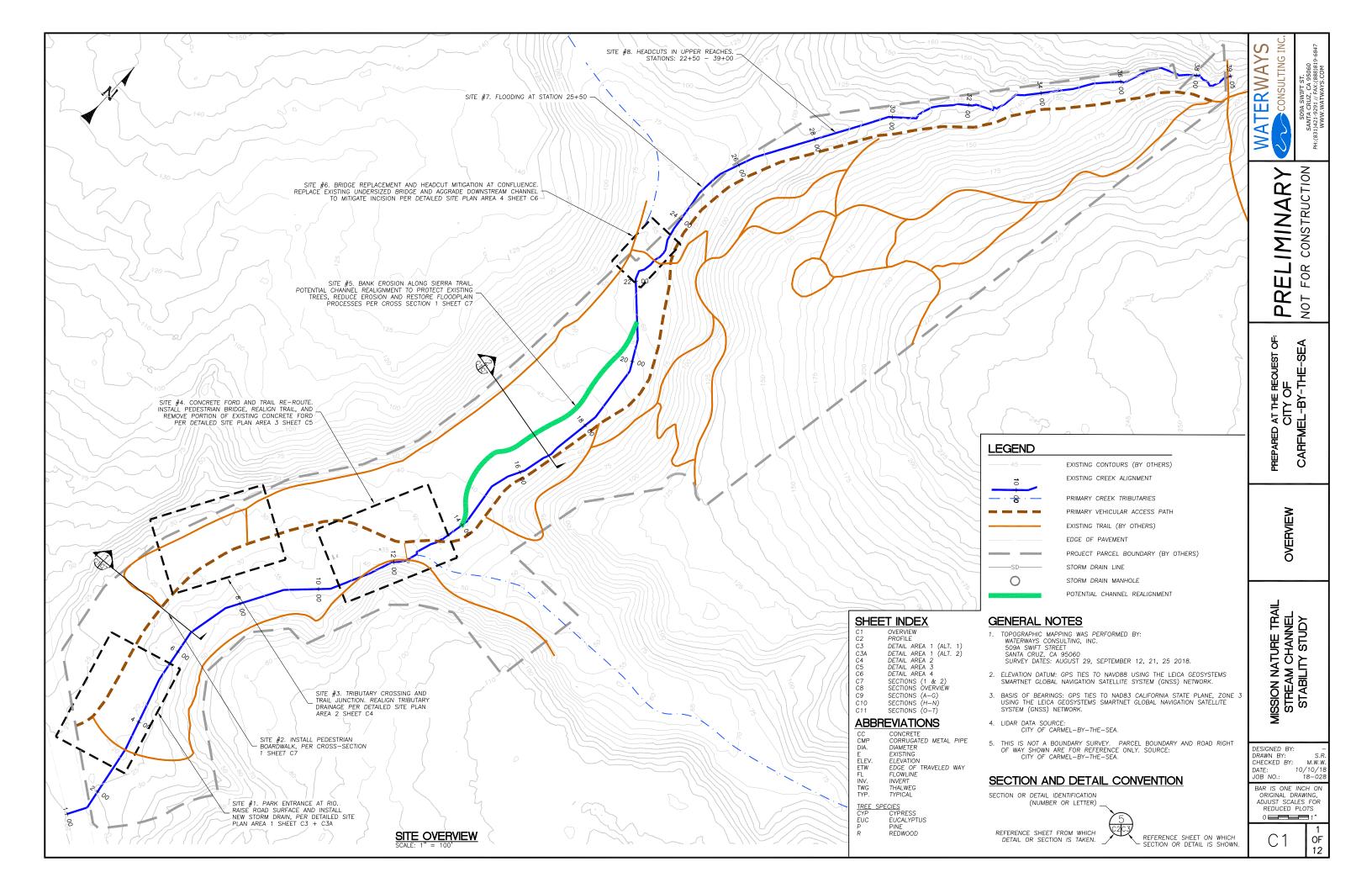
The cost of Project #8 cannot be estimated until further analysis is completed to determine the appropriate scale of the repair work required, which will vary based on geologic/geotechnical considerations, land ownership, and risk. Costs have been estimated for that analysis.

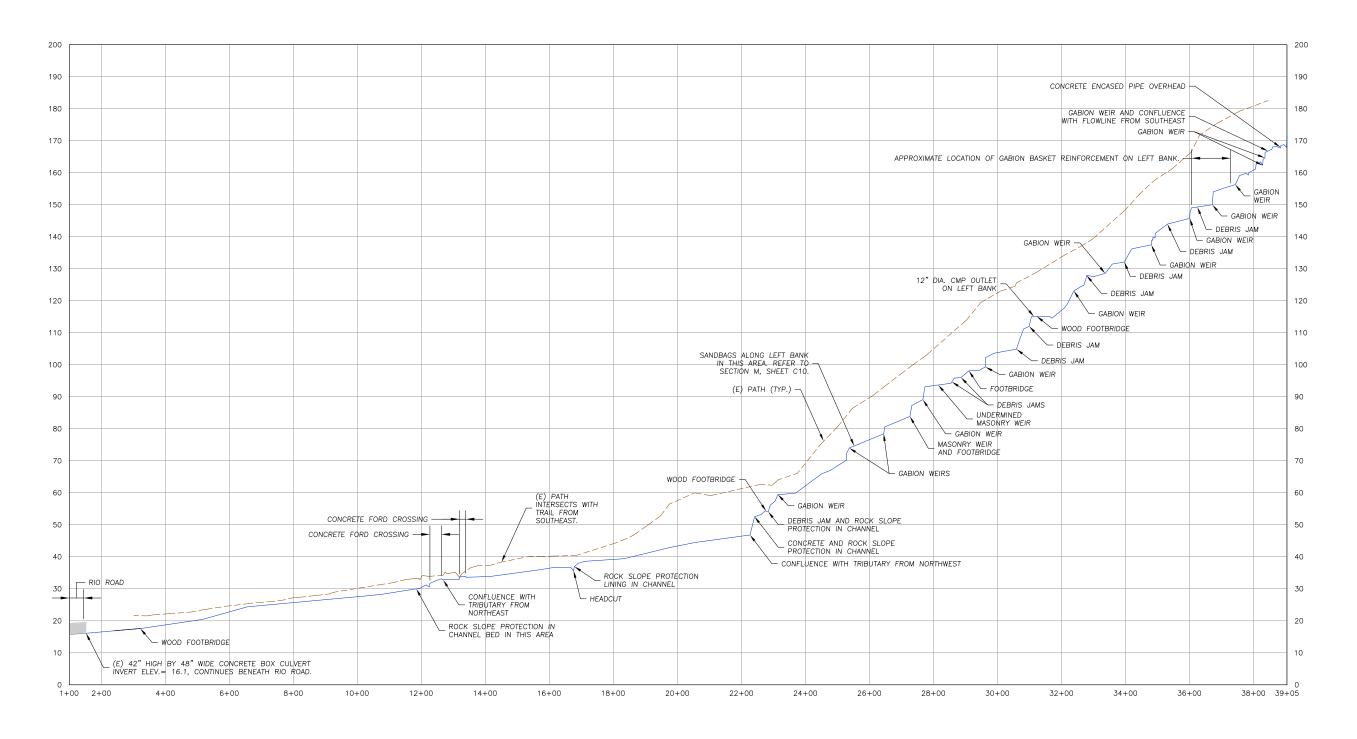
The cost of environmental review (CEQA) and regulatory permitting would be an additional cost if the City elects to hire a consultant for these tasks rather than complete with City staff. It is likely that categorical exemptions could be used for most recommendations. Permitting includes preparation of application and application materials, and likely will require technical reports including biological resources and cultural resources evaluations, and a formal jurisdictional delineation. Costs for permitting can typically range from \$20,000 to \$35,000 or more depending on the extent of needed biological reviews. Costs could be higher for Project #5, which would likely require a mitigation and restoration plan with multi-year monitoring for revegetation along a realigned channel.

Table 6: Project Design and Implementation Costs

		APPROX	APPROXIMATE COSTS	
PROJECT AREA	PROJECT COMPONENTS	DESIGN	IMPLEMENTATION & ESTABLISHMENT	
1 (Alt 1)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT OPEN SWALE TO CREEK	\$17,000	\$90,000	
1 (Alt 2)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT PIPE TO CREEK	\$17,000	\$95,000	
1 (Alt 3)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD	\$15,000	\$75,000	
2	CONSTRUCT APPROX. 100 LF PEDESTRIAN BOARDWALK	\$8,000	\$40,000	
3	INSTALL CULVERT OR ROCKED FORD AND REALIGN TRIBUTARY DRAINAGE, INSTALL SMALL DITCH CULVERT AND PERFORM DITCH MAINTENANCE	\$7,500	\$22,500	
4	DEMOLISH PORTION OF EXISTING FORD, RESTORE DOWNSTREAM REACH OF CHANNEL, REALIGN TRAIL, CONSTRUCT PEDESTRIAN BRIDGE, RESTORE OLD TRAIL ALIGNMENT	\$17,500	\$100,000	
5	REALIGN APPROX. 700 LF OF CHANNEL. RESTORE OLD CHANNEL BED, REVEGETATE DISTURBED AREAS	\$27,500	\$300,000	
6	REPLACE EXISTING UNDERSIZED BRIDGE, RESTORE DOWNSTREAM CHANNEL AND ARMOR REACH TO PREVENT FURTHER INCISION UPSTREAM	\$25,000	\$230,000	
7	REMOVE EXISITING WEIR, LOWER CHANNEL, STABILIZE NEW CHANNEL BED AND BANKS	\$9,500	\$30,000	
8	PERFORM BOUNDARY SURVEY, DETAILED TOPOGRAPHY, GEOLOGIC & GEOTECHNICAL INVESTIGATION. PRIORITIZE A PHASED REPAIR PLAN, AND PREPARE PRELIMINARY AND FINAL DESIGNS FOR GRADE CONTROL.	\$50,000	N/A	







PROFILE SCALE: 1" = 150'H ; 1" = 15'V

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PROFILE

MISSION NATURE TRAIL STREAM CHANNEL STABILITY STUDY

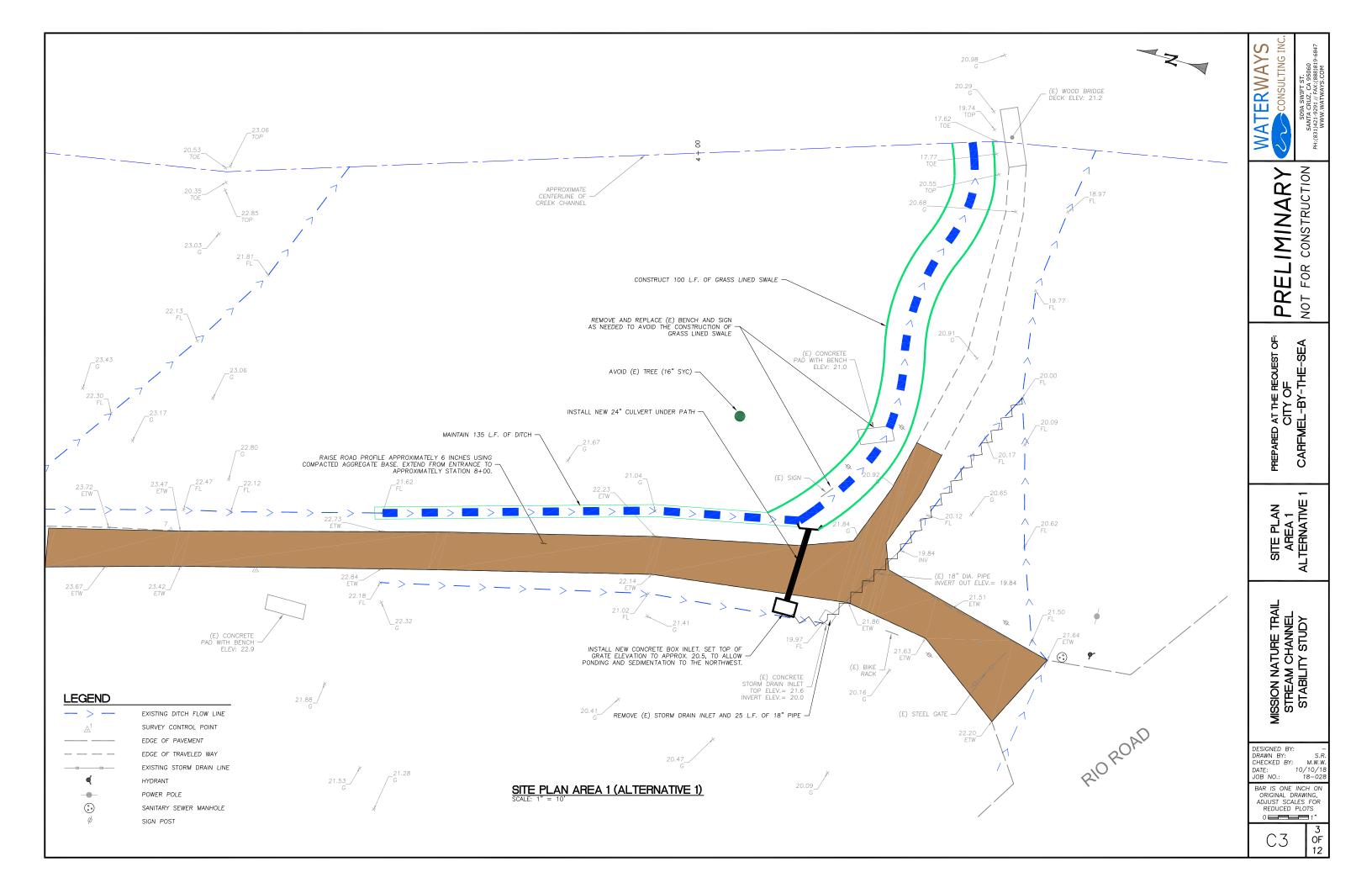
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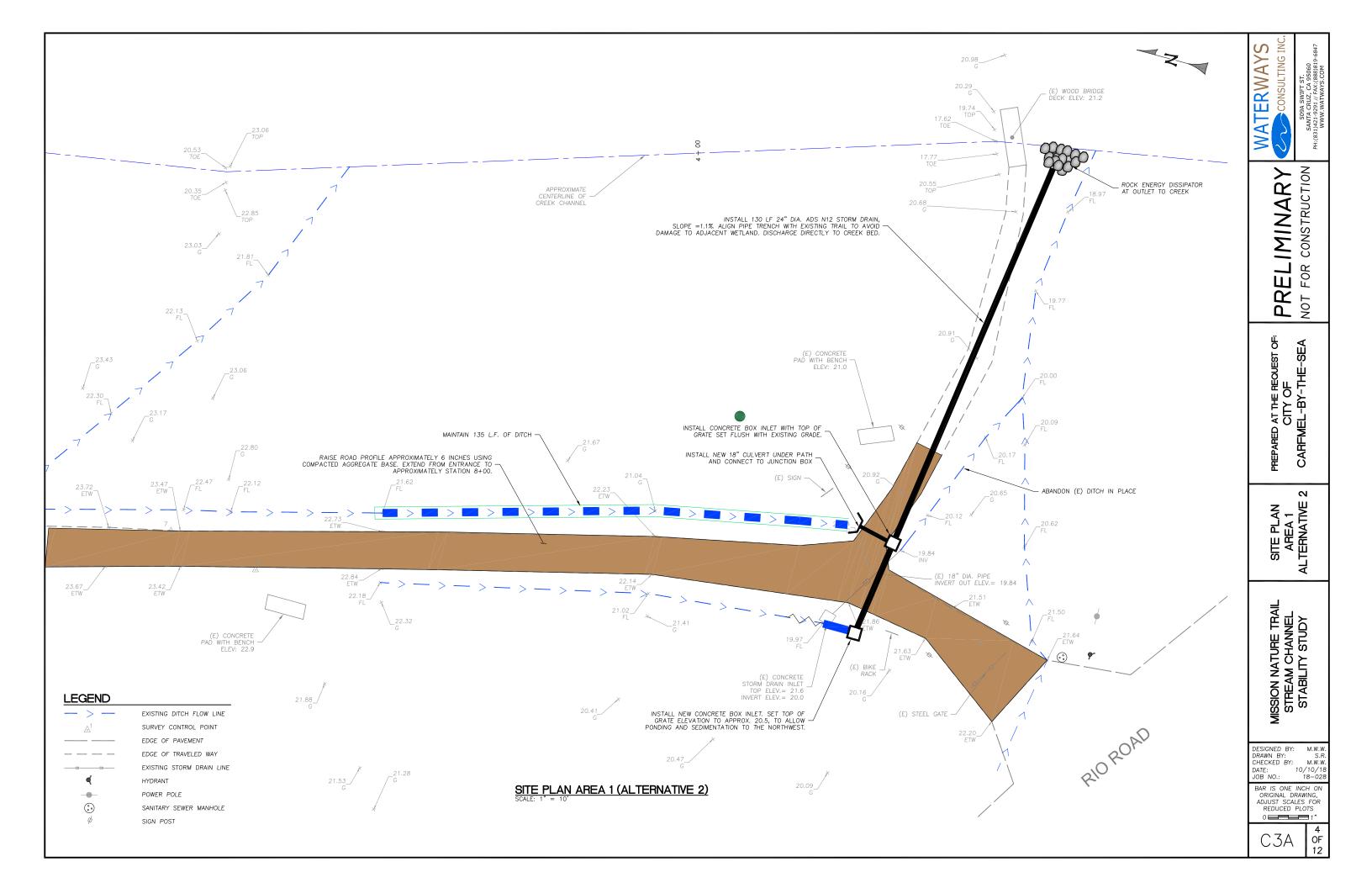
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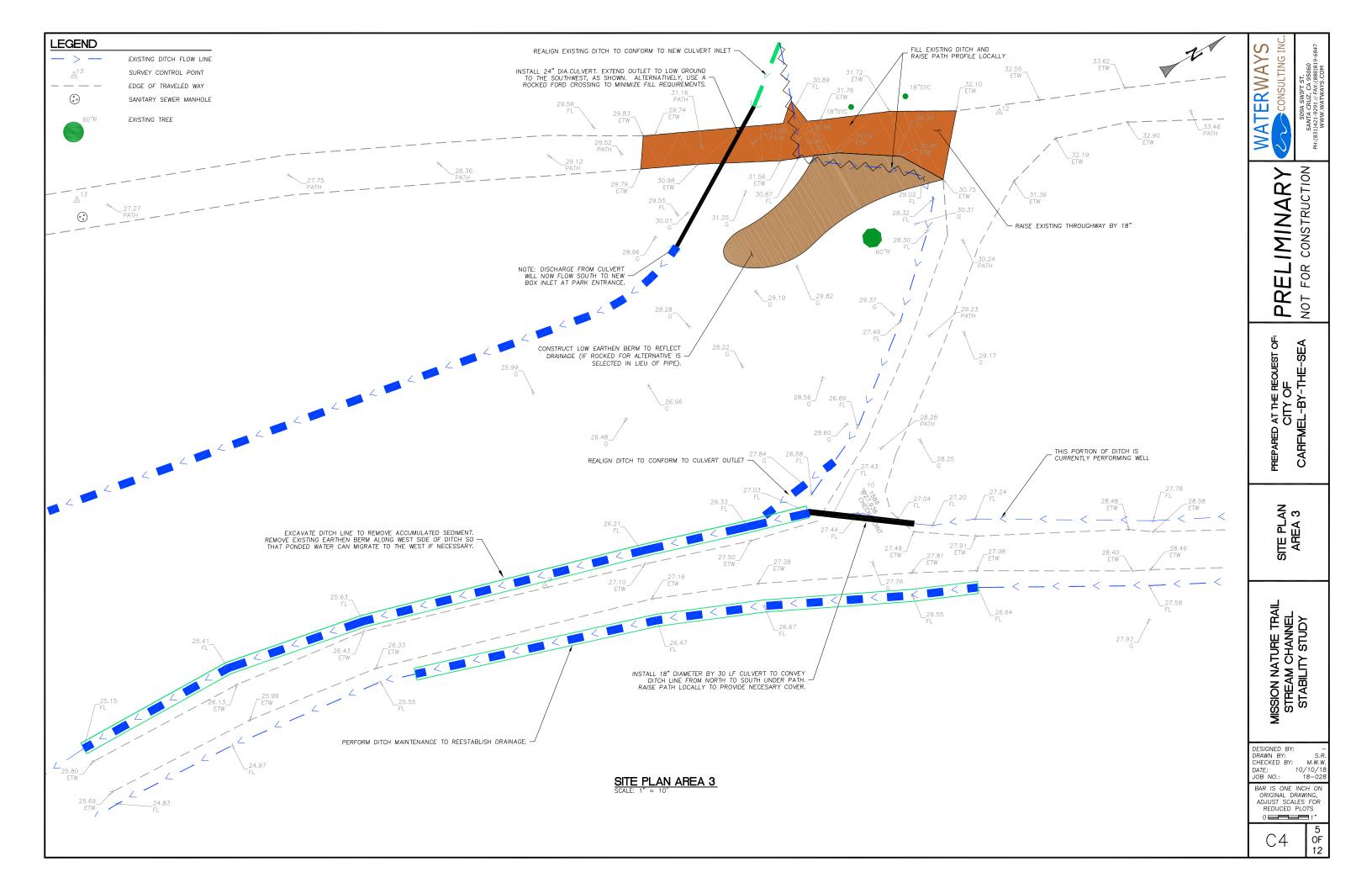
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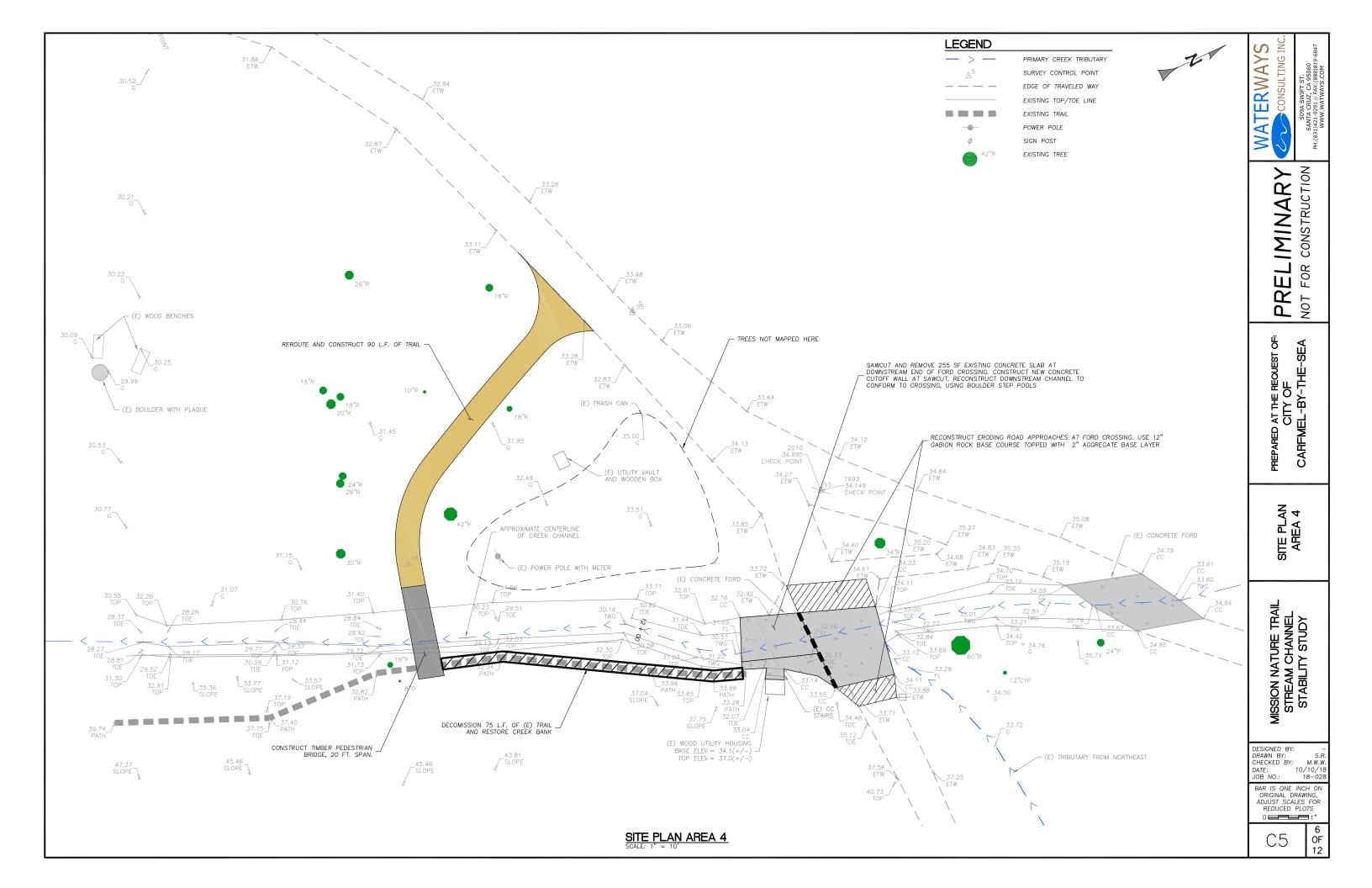
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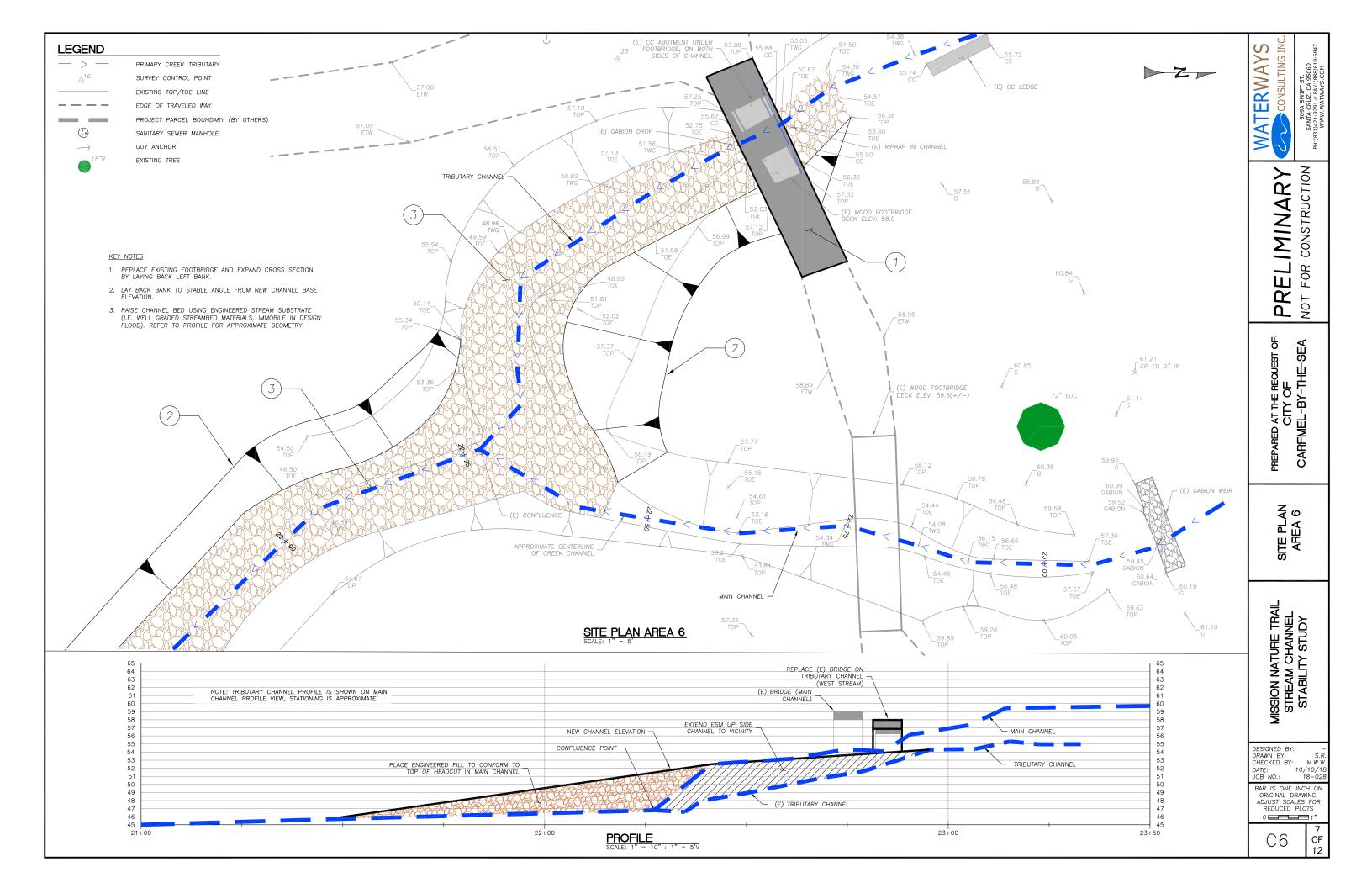
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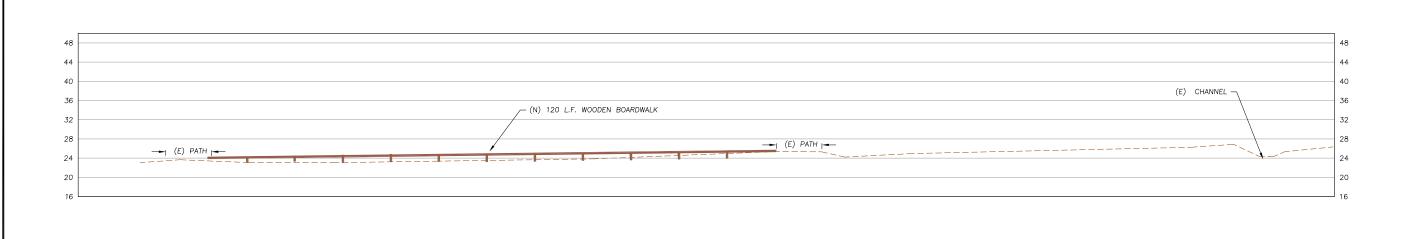




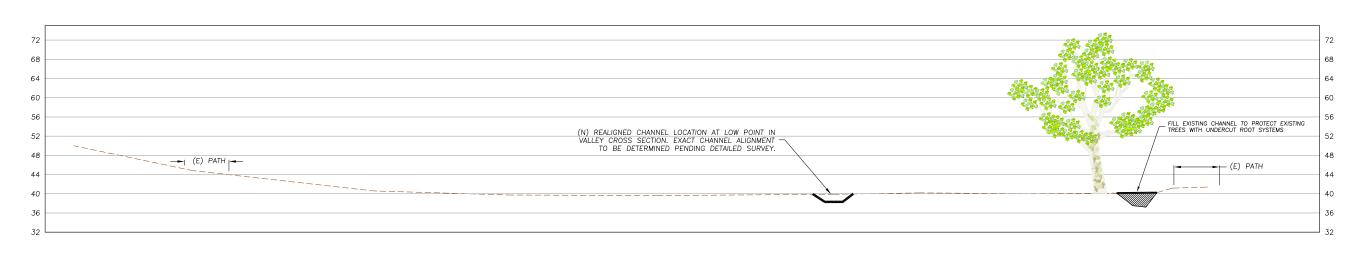








SECTION SCALE: 1" = 10"





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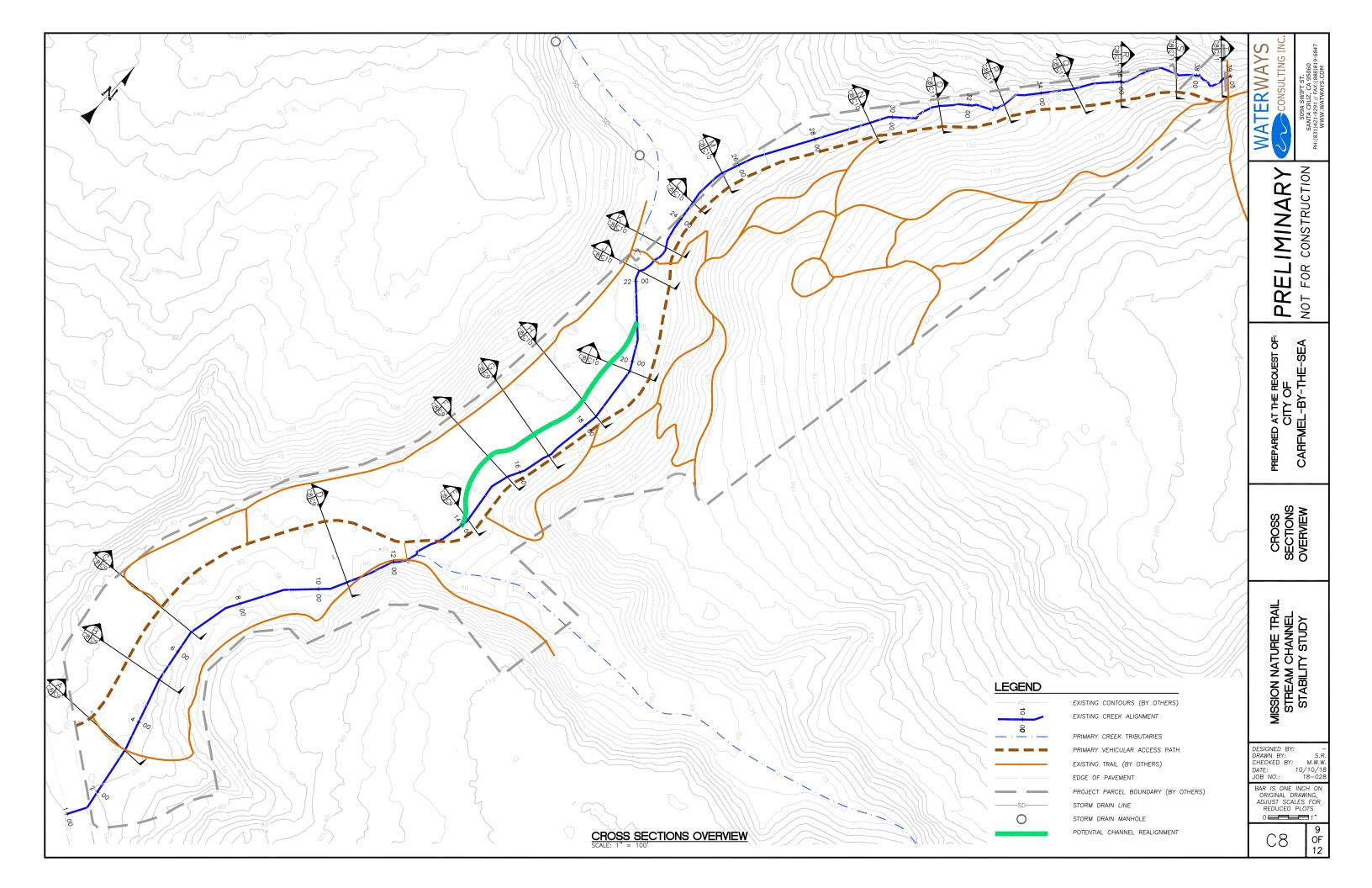
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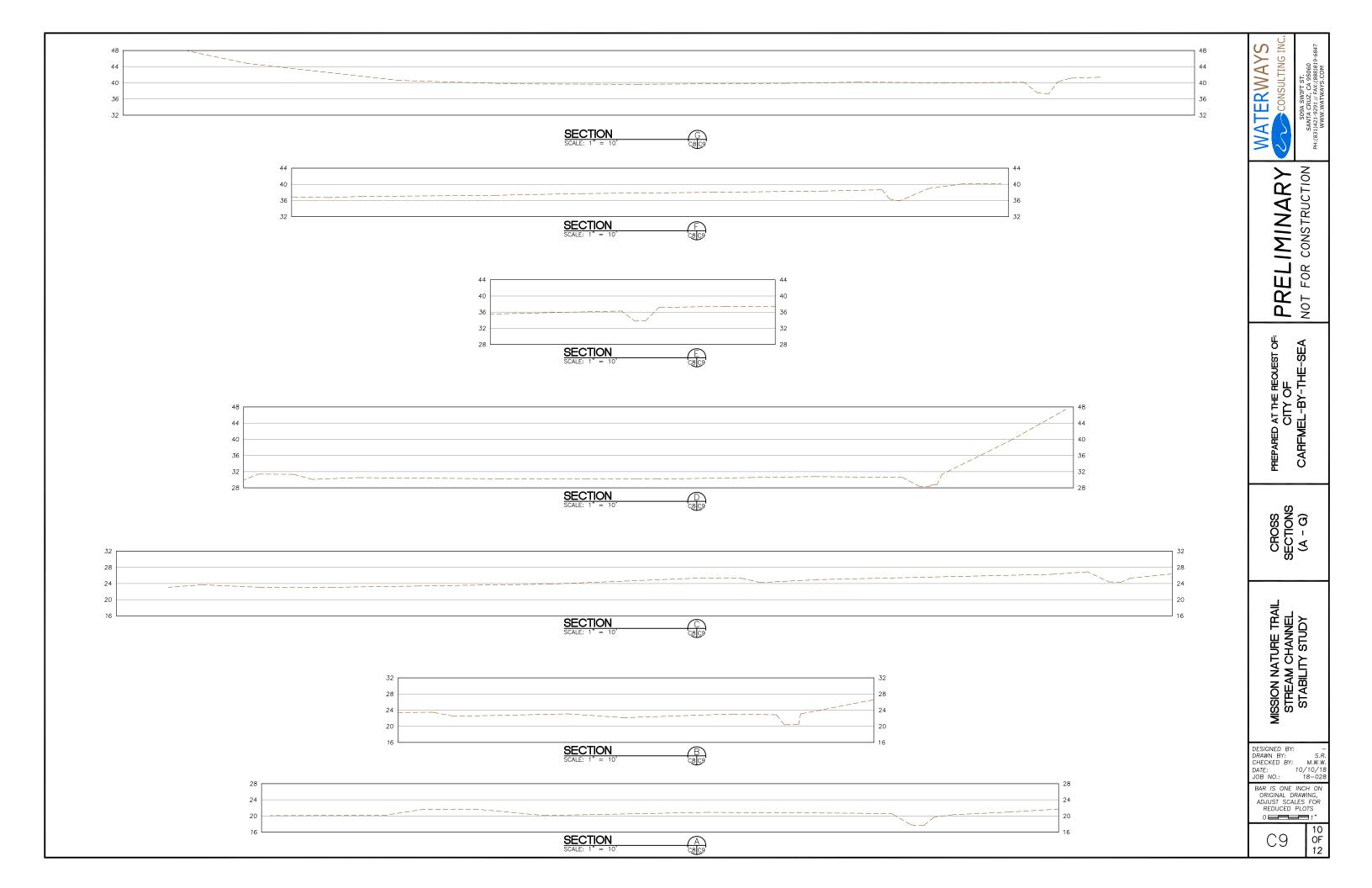
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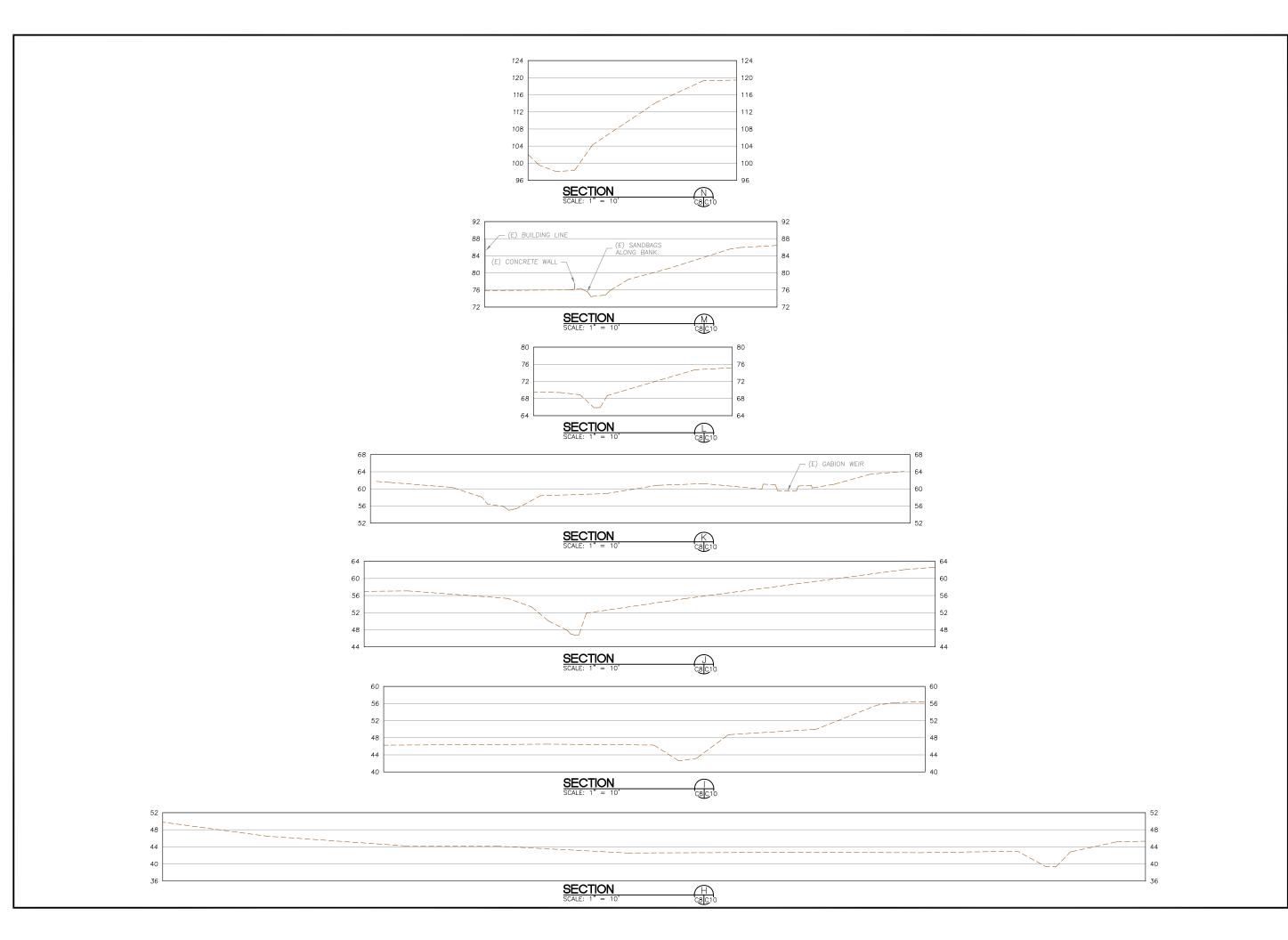
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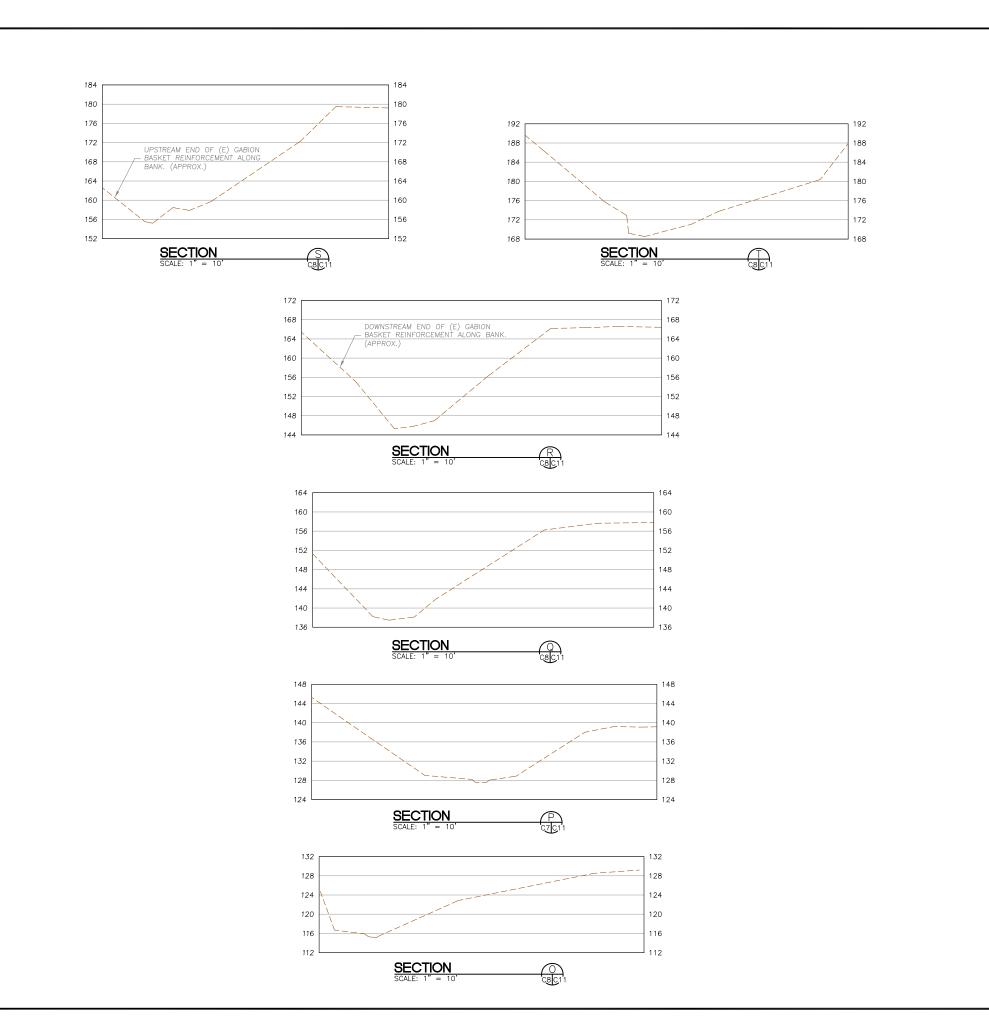
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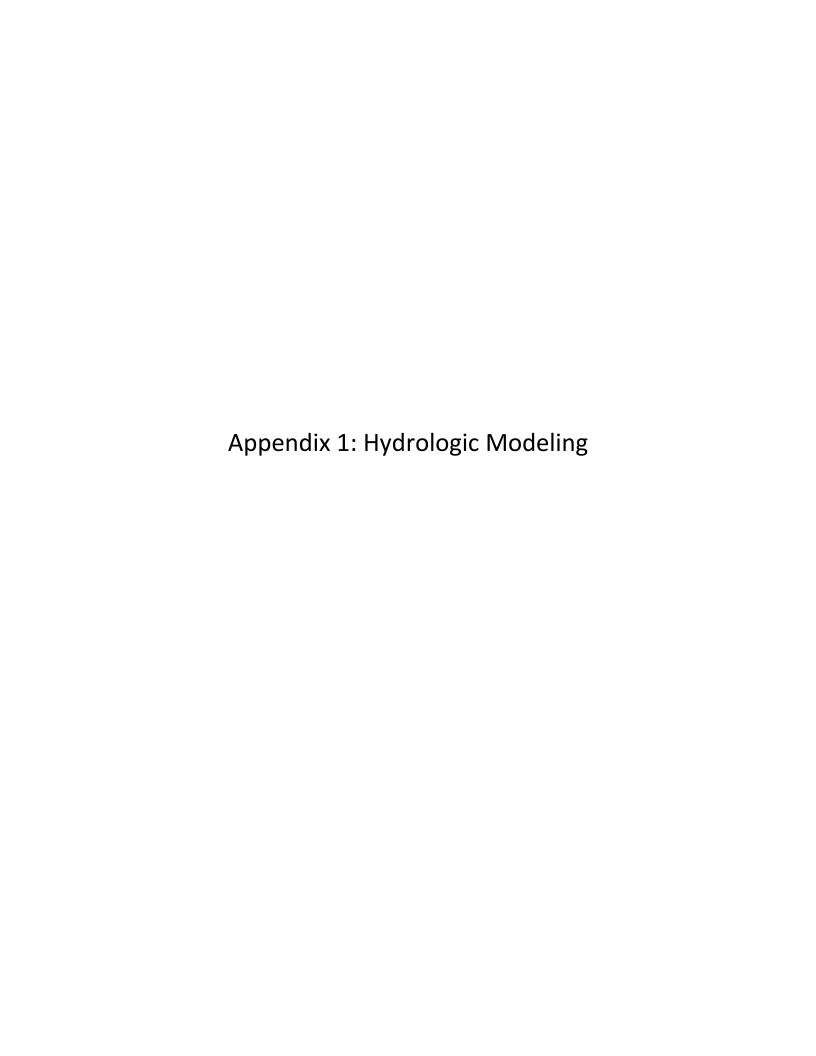
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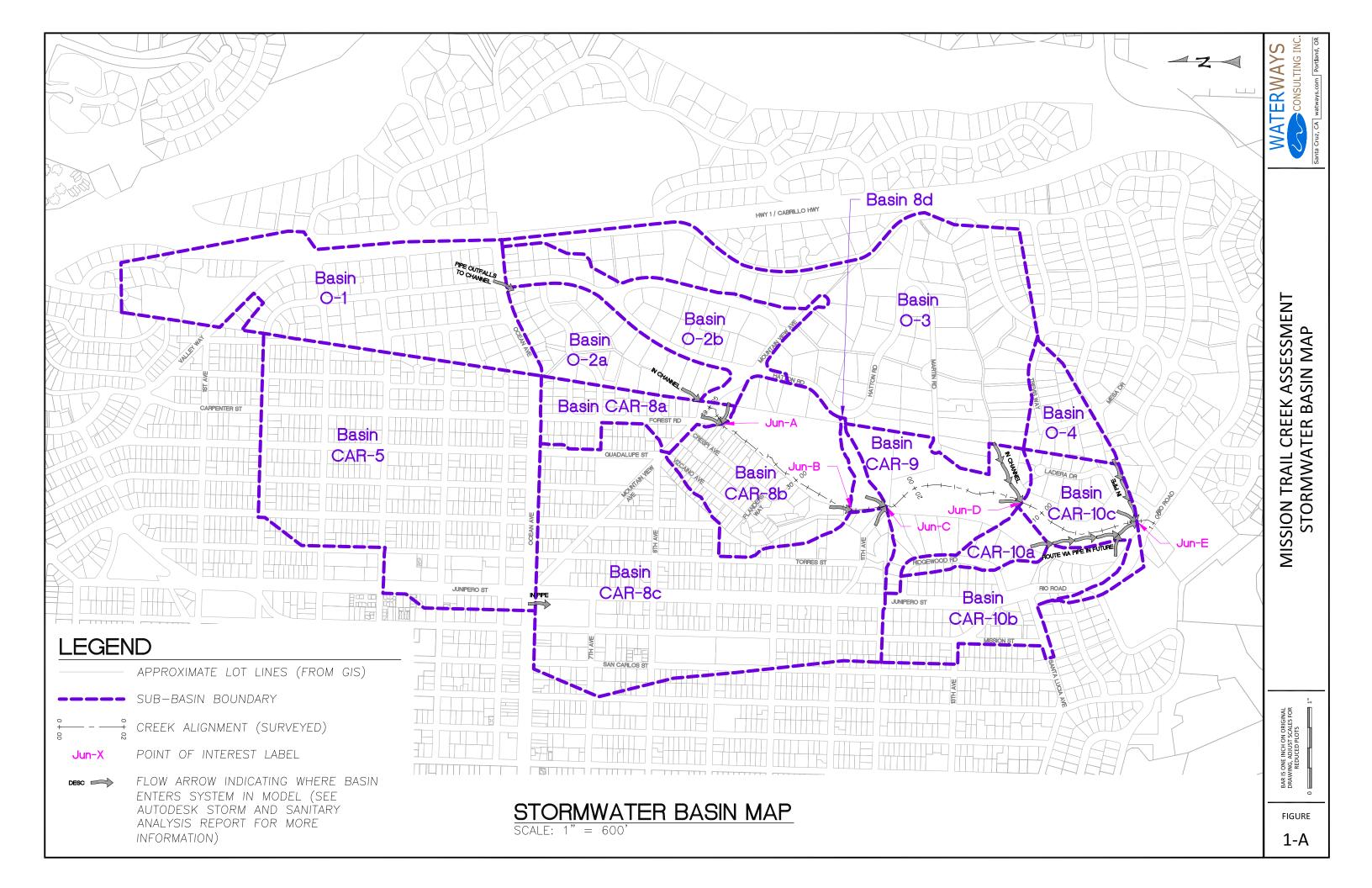
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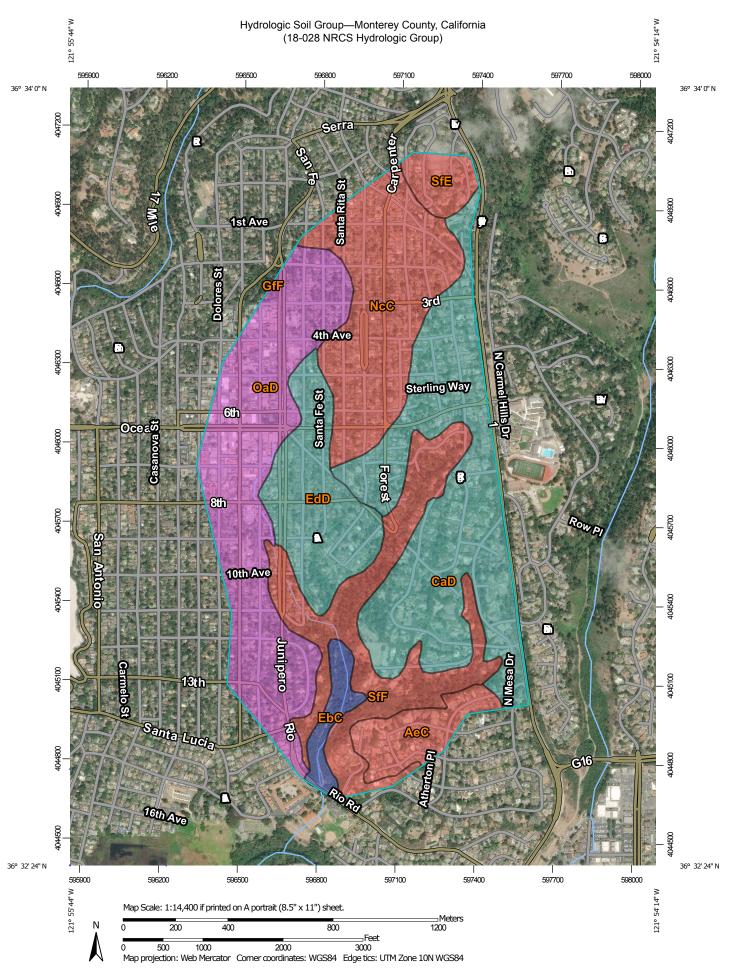
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Appendix 1-B:
NRCS Hydrologic Soil Report



MAP LEGEND MAP INFORMATION The soil surveys that comprise your AOI were mapped at Area of Interest (AOI) С 1:24.000. Area of Interest (AOI) C/D Please rely on the bar scale on each map sheet for map Soils D measurements. Soil Rating Polygons Not rated or not available Α Source of Map: Natural Resources Conservation Service Web Soil Survey URL: **Water Features** A/D Coordinate System: Web Mercator (EPSG:3857) Streams and Canals В Maps from the Web Soil Survey are based on the Web Mercator Transportation projection, which preserves direction and shape but distorts B/D Rails --distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more Interstate Highways accurate calculations of distance or area are required. C/D **US Routes** This product is generated from the USDA-NRCS certified data as D Major Roads of the version date(s) listed below. Not rated or not available -Local Roads Soil Survey Area: Monterey County, California Soil Rating Lines Survey Area Data: Version 15, Sep 17, 2018 Background Aerial Photography Soil map units are labeled (as space allows) for map scales 1:50,000 or larger. Date(s) aerial images were photographed: Dec 31, 2009—Sep 15, 2017 B/D The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor C/D shifting of map unit boundaries may be evident. D Not rated or not available **Soil Rating Points** Α A/D В B/D

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AeC	Antioch very fine sandy loam, 2 to 9 percent slopes	D	23.7	4.4%
CaD	Chamise channery loam, 9 to 15 percent slopes, MLRA 15	С	139.1	26.0%
EbC	Elder very fine sandy loam, 2 to 9 percent slopes	В	12.3	2.3%
EdD	Elkhorn fine sandy loam, 9 to 15 percent slopes	С	55.8	10.4%
GfF	Gazos silt loam, 30 to 50 percent slopes	С	0.1	0.0%
NcC	Narlon loamy fine sand, 2 to 9 percent slopes	D	88.6	16.5%
OaD	Oceano loamy sand, 2 to 15 percent slopes	А	124.4	23.2%
SfE	Santa Lucia channery clay loam, 15 to 30 percent slopes, MLRA 15	D	13.3	2.5%
SfF	Santa Lucia channery clay loam, 30 to 50 percent slopes, MLRA 15	D	78.2	14.6%
Totals for Area of Inter	rest	535.3	100.0%	

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix 1-C:

Tables

Table 1: Mission Trail Stormwater Sub-Basin Curve Number Calculations

		Sub-discharge			Area	Hydrologic	Pervious	%	Developed	Average	
Discharge Point	Discharge Description	Point	Basin	Area (sq.ft.)	(acre)	Soil Group	CN	Developed	Area CN	CN	Notes
-	Upstream end of aligment		0-1	2,106,429	48.36	С			83	83	Avg lot size 1/4 acre
	,		CAR-8a	466,353	10.71				91		Avg lot size <1/8 acre
Jun-A	Upstream end of steep section		O-2a	749,813	17.21	D	79	67%	87	84	Avg lot size 1/4 acre
			O-2b	911,780	20.93	С			83	83	Avg lot size 1/4 acre
Jun-B	Carmel outfall & downstream end					Drainage: D					
Juli-B	of steep section		CAR-8b	1,228,697	28.21	Upland: C	79	50%	90	85	Avg lot size <1/8 acre
			CAR-5	3,421,882	78.56	C/D			91	91	Avg lot size <1/8 acre
Jun-C	Little bridge		CAR-8c	3,513,081	80.65	A/C			81	81	Avg lot size <1/8 acre
			CAR-8d	84,785	1.95	C/D			91	91	Avg lot size <1/8 acre
Jun-D	Bridge		CAR-9	834,223		Drainage: B Upland: D	60	38%	92	72	Avg lot size <1/8 acre
	_		CAR-O3	3,162,327	72.60	С			83	83	Avg lot size 1/4 acre
		Area 2 culvert	CAR-10a	220,906		Drainage: B Upland: D	60	66%	92	81	Avg lot size <1/8 acre
F	Downstream culvert/end of	Area 1 culvert	CAR-10b	936,710	21.50	A	36	90%	77	73	Avg lot size <1/8 acre
Jun-E	alignment					Drainage: B					
			CAR-10c	549,567	12.62	Upland: D	60	50%	87	74	Avg lot size 1/4 acre
			0-4	340,815	7.82	D			87	87	Avg lot size 1/4 acre

Note: CN Values from Table 2-2a of USDA NRCS Urban Hydrology for Small Watershed TR-55

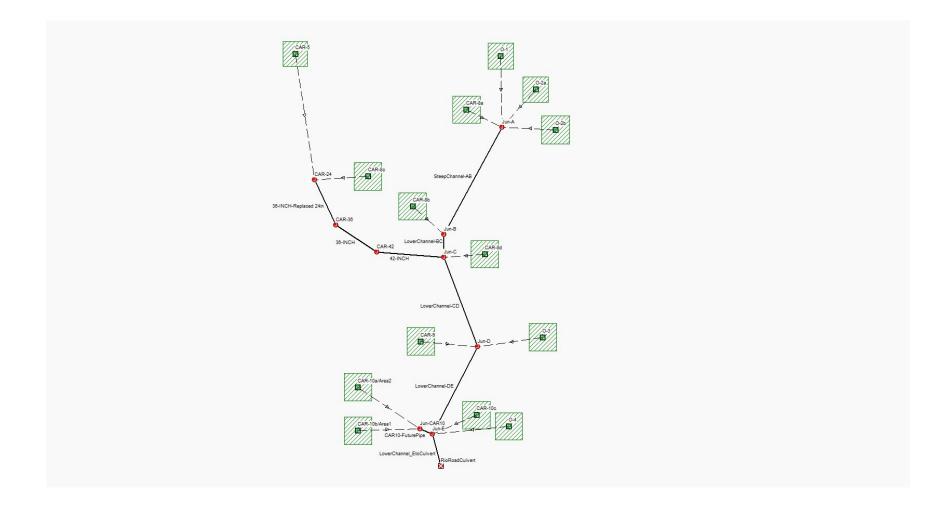
Storm Event Peak flow (cfs) Point of Interest 10-year 50-year 2-year 100-year Jun-A 6.09 42.09 46.36 27.71 Jun-B 59.91 8.04 35.80 54.39 Jun-C 27.02 97.31 142.13 155.30 Jun-D 30.65 117.23 174.08 190.87 204.81 Jun-E 31.28 124.10 186.31 4.24 4.95 Area 1 0.22 2.05 2.16 Area 2 0.18 1.22 1.95 0.32 3.21 6.18 7.11 Area 1 & 2 Combined

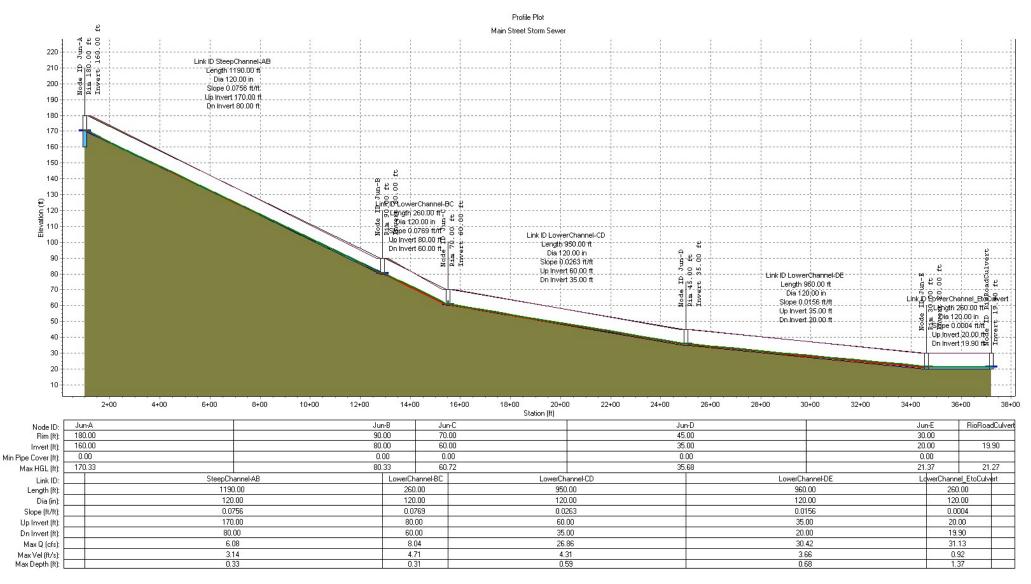
Table 2: Mission Trail Stormwater Flow Summary

Assumptions:

- · SCS Type 1A 24-hr storm for Pebble Beach used
- · SBUH used on all sub-basins
- · Minimum TOC of 5 minutes
- · Pipe inverts and slopes assumed based on surface topography.
- · Initial modeling revealed that the 24" pipe located at the corner of Ocean Avenue, Junipero Avenue, and Mountain View Avenue in Carmel's sub-basin CAR-8 is undersized, causing surcharging of the catch basins in Ocean Ave and a net loss out of the system due to overland flow. It was assumed that the existing 24" pipe will be upsized to a 36" pipe in the future, so the pipe was modeled 36" pipe. Note this only affects the 24" portion of the pipe system. The downstream 36" and 42" portions were modeled as 36" and 42" pipes, respectively. See the Storm and Sanitary Analysis results for more information.

Appendix 1-D: Storm and Sanitary Analysis Reports





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Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)
******
Project Description
Analysis Options
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date ..... OCT-15-2018 00:00:00
Ending Date ..... OCT-17-2018 00:00:00
Report Time Step ..... 00:00:10
*****
Element Count
Number of rain gages ..... 1
Number of subbasins ..... 14
Number of nodes ..... 10
Number of links ..... 9
*****
Raingage Summary
Gage Data Data Recording ID Source Type Interval
_____
PebbleBeach 002-year CUMULATIVE 6.00
*****
Subbasin Summary
*****
CAR-10a/Area2 220905.11 0.00 PebbleBeach CAR-10b/Area1 936706.23 0.00 PebbleBeach CAR-10c 549564.77 0.00 PebbleBeach CAR-5 3421768.38 0.00 PebbleBeach CAR-8a 466351.13 0.00 PebbleBeach CAR-8b 1228692.05 0.00 PebbleBeach CAR-8b 3513067.02 0.00 PebbleBeach CAR-8c 3513067.02 0.00 PebbleBeach CAR-8d 84784.75 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach O-1 2106420.50 0.00 PebbleBeach O-2a 749809.98 0.00 PebbleBeach O-2b 911776.34 0.00 PebbleBeach O-3 3162314.26 0.00 PebbleBeach O-4 340813.63 0.00 PebbleBeach
_____
++++++++++
Node Summary
```

Node	Element			Maximun			Externa		
ID	Туре		ft ft	Elev. ft		rea ft²	Inflo	W	
CAR-24 CAR-36 CAR-42	JUNCTION JUNCTION JUNCTION JUNCTION	18	26.50 34.00 23.00	230.00 190.00 130.00) 4	.00		_	
Jun-A Jun-B Jun-C	JUNCTION JUNCTION JUNCTION	17 8	70.00 80.00 50.00	180.00 90.00 70.00	0 0	.00			
Jun-CAR10 Jun-D Jun-E RioRoadCulvert	JUNCTION JUNCTION JUNCTION OUTFALL	3	21.00 35.00 20.00		0	.00			
*********** Link Summary *****									
Link ID	From Node	To Node		Element Type		ft		용	Manning's Roughness
36-INCH 36-INCH-Replaced	CAR-36 1 24inCAR-24	CAR-42 CAR-3		CONDUIT CON					
42-INCH CAR10-FuturePipe LowerChannel_Etc	CAR-42 eJun-CAR10 cCulvertJun-E	Jun-C Jun-E Ric	RoadCu	CONDUIT CONDUIT llvert (CHANNEL	1153.0 50.0	5.4 2.0 260.0	640 000 0.	0.0150 0.0150 0385
0.0250 LowerChannel-BC LowerChannel-CD	Jun-B	Jun-C Jun-D		CHANNEL CHANNEL		260.0	7.6	923	
LowerChannel-DE SteepChannel-AB	Jun-D	Jun-E Jun-B		CHANNEL CHANNEL		960.0	1.5	625	0.0250
**************************************	ımmary								
**************************************		Denth/		Width	No	of	Cri	200	Full Flow
Design	Shape	_		WIGGI					
ID Flow		Diameter			Bar	rels	Section	nal	Hydraulic
Capacity							A:	rea	Radius
cfs		ft		ft			:	ft²	ft
	CIRCULAR	3.00		3.00		1	7	.07	0.75
135.69 36-INCH-Replaced 0.75 111.17	d 24in CIRCULAR	3	3.00	3.	00		1	7.	07
42-INCH 203.82	CIRCULAR	3.50		3.50		1	9	.62	0.88
CAR10-FuturePipe	e CIRCULAR	1.25		1.25		1	1	.23	0.31
LowerChannel_Etc 4.99 6214.43	Culvert TRIANGU	LAR	10.00	36	55.00		1	182	5.00
LowerChannel-BC 87885.25	TRIANGULAR	10.00	3	865.00		1	1825	.00	4.99
LowerChannel-CD 51403.88				865.00		1	1825	.00	4.99
LowerChannel-DE 39609.35				865.00		1	1825		4.99
SteepChannel-AB	'I'RIANGULAR	10.00	3	865.00		1	1825	.00	4.99

54464.74

******	Volume	Depth		
Runoff Quantity Continuity	acre-ft	inches		
Total Precipitation	53.166	1.500		
Surface Runoff	15.846	0.447		
Continuity Error (%)	0.000			
******	Volume	Volume		
Flow Routing Continuity	acre-ft	Mgallons		
External Inflow	0.000	0.000		
External Outflow	15.834	5.160		
Initial Stored Volume Final Stored Volume	0.000	0.000		
Continuity Error (%)	0.000 0.001	0.000		

Composite Curve Number Computa	tions Report			
Subbasin CAR-10a/Area2				
		Area	Soil	
Soil/Surface Description		(ft²)	Group	CN
Composite Area & Weighted CN		220905.11	-	81.00
Subbasin CAR-10b/Area1				
Soil/Surface Description		Area		CN
Soil/Surface Description		(ft²)		
Composite Area & Weighted CN		936706.23	3	73.00
Subbasin CAR-10c				
Soil/Surface Description		Area (ft²)		CN
Composite Area & Weighted CN		549564.77		74.00
Subbasin CAR-5				
		7	0 - 1 1	
Soil/Surface Description		Area (ft²)	Soil Group	CN
Composite Area & Weighted CN		3421768.38	 }	91.00
Subbasin CAR-8a				
		Area	Soil	
Soil/Surface Description		(ft²)		CN
Composite Area & Weighted CN		466351.13	3	91.00
Subbasin CAR-8b				

	Area	Soil	
Soil/Surface Description		Group	CN
Composite Area & Weighted CN	1228692.05		85.00
Subbasin CAR-8c			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	
Composite Area & Weighted CN	3513067.02		85.00
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00
Subbasin 0-1			
	7	C1	
Soil/Surface Description		Soil Group	
Composite Area & Weighted CN	2106420.50		83.00
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00
Subbasin 0-2b			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00
Subbasin 0-3			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	CN
Composite Area & Weighted CN	3162314.26		83.00
Subbasin 0-4			
Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63		87.00

Subbasin CAR-10a/Area2			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	220905.11 220905.11		0.72 0.72
Subbasin CAR-10b/Area1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	936706.23 936706.23	-	0.72 0.72
Subbasin CAR-10c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	549564.77 549564.77		0.72 0.72
Subbasin CAR-5			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	4718448.95 4718448.95	-	0.72 0.72
Subbasin CAR-8a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	466351.13 466351.13	-	0.72 0.72
Subbasin CAR-8b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	1228692.05 1228692.05	-	0.72 0.72
Subbasin CAR-8c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

- Composite Area & Weighted Runoff Coeff.	3513067.02 3513067.02	-	0.72 0.72
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	84784.75 84784.75	-	0.72 0.72
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	834219.64 834219.64	-	0.72 0.72
Subbasin O-1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	2106420.50 2106420.50	-	0.72 0.72
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	749809.98 749809.98	-	0.72 0.72
Subbasin O-2b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	911776.34 911776.34	-	0.72 0.72
Subbasin O-3			
Soil/Surface Description		Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	3162314.26 3162314.26	-	0.72 0.72
Subbasin O-4			
Soil/Surface Description		Soil Group	Runoff Coeff.

```
SCS TR-55 Time of Concentration Computations Report
  Sheet Flow Equation
           Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))
           Where:
           Tc = Time of Concentration (hrs)
           n = Manning's Roughness
           Lf = Flow Length (ft)
           P = 2 yr, 24 hr Rainfall (inches)
           Sf = Slope (ft/ft)
  Shallow Concentrated Flow Equation
           V = 16.1345 * (Sf^0.5) (unpaved surface)
           V = 20.3282 * (Sf^0.5) (paved surface)
           V = 15.0 * (Sf^0.5) (grassed waterway surface)
           V = 10.0 * (Sf^0.5)  (grassed waterway surface)

V = 10.0 * (Sf^0.5)  (nearly bare & untilled surface)

V = 9.0 * (Sf^0.5)  (cultivated straight rows surface)
           V = 7.0 * (Sf^0.5) (short grass pasture surface)
           V = 5.0 * (Sf^0.5) (woodland surface)

V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
           Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           V = Velocity (ft/sec)
Sf = Slope (ft/ft)
  Channel Flow Equation
           V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n
           R = Aq / Wp

Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           R = Hydraulic Radius (ft)
           Aq = \overline{Flow} Area (ft^2)
           Wp = Wetted Perimeter (ft)
           V = Velocity (ft/sec)
           Sf = Slope (ft/ft)
           n = Manning's Roughness
  Subbasin CAR-10a/Area2
  Sheet Flow Computations
                                                        Subarea A
                                                                             Subarea B
                                                                                                     Subarea
                                                             0.04
                                                                                     0.00
         Manning's Roughness:
                                                             65.00
                                                                                     0.00
          Flow Length (ft):
0.00
```

С

0.00	Slope (%):	0.77	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.21	0.00	
0.00	Computed Flow Time (minutes):	5.16	0.00	
Channel	Flow Computations			
С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	1180.00	884.00	
0.00	Channel Slope (%):	8.05	7.49	
0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	12.47	29.81	
0.00	Computed Flow Time (minutes):	1.58	0.49	
0.00				
=======	Total TOC (minutes):	3.62	===========	=========

Subbasin CAR-10b/Area1

Sheet Flow Computations

С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	111.00	0.00	
0.00	Slope (%):	1.80	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.33	0.00	
0.00	Computed Flow Time (minutes):	5.64	0.00	
0.00	compaced from from (managed),	0.01	0.00	
Channe	l Flow Computations			
~		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2186.00	0.00	
0.00	Channel Slope (%):	5.43	0.00	
0.00	Cross Section Area (ft ²):	0.38	0.00	
0.00	, , , ,			

	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	10.24	0.00	
0.00	<u>-</u>	3.56	0.00	
0.00	Computed Flow Time (minutes):	3.30	0.00	
	Total TOC (minutes):	9.19		
Subbas	in CAR-10c			
Sheet	Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	106.00	0.00	
0.00	Slope (%):	0.94	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	7.04	0.00	
Channe	el Flow Computations			
~		Subarea A	Subarea B	Subarea
C 0.00	Manning's Roughness:	0.01	0.04	
	Flow Length (ft):	954.00	884.00	
0.00	Channel Slope (%):	8.91	7.49	
0.00	Cross Section Area (ft²):	0.75	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	20.82	29.81	
0.00	Computed Flow Time (minutes):	0.76	0.49	
======	Total TOC (minutes):	4.15		
======				
Subbas	in CAR-5			
	Flow Computations			
C		Subarea A	Subarea B	Subarea

Ma	anning's Roughness:	0.04	0.00	
	low Length (ft):	108.00	0.00	
	lope (%):	0.93	0.00	
	yr, 24 hr Rainfall (in):	1.50	1.50	
	elocity (ft/sec):	0.25	0.00	
	omputed Flow Time (minutes):	7.18	0.00	
	low Computations			
		Subarea A	Subarea B	Subar
M	annianta Daumhaana			Subar
	anning's Roughness:	0.01	0.01	
	low Length (ft):		2541.00	
	hannel Slope (%):	6.90	6.49	
Ci	ross Section Area (ft²):	0.38	3.14	
We	etted Perimeter (ft):	1.58	6.28	
Ve	elocity (ft/sec):	11.54	18.39	
Co	omputed Flow Time (minutes):	3.59	2.30	
T	otal TOC (minutes):	6.54		
T(otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
To	otal TOC (minutes): CAR-8a w Computations	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
bbasin (eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness:	6.54 Subarea A 0.04	Subarea B	
eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft):	6.54 Subarea A 0.04 108.00	Subarea B 0.00 0.00	
bbasin (eet Flow F: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%):	Subarea A 0.04 108.00 1.85	Subarea B 0.00 0.00 0.00	
bbasin (eet Flow S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in):	Subarea A 0.04 108.00 1.85 1.50	Subarea B 0.00 0.00 0.00 1.50	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33	Subarea B 0.00 0.00 0.00 1.50 0.00	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	Subar
bbasin (eet Flow F: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes): low Computations	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B	Subar
bbasin (eet Flor S: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	

Channel Slope (%):	1.37	0.00	
Cross Section Area (ft²):	0.38	0.00	
Wetted Perimeter (ft):	1.58	0.00	
Velocity (ft/sec):	5.14	0.00	
Computed Flow Time (minutes):	4.10	0.00	
Total TOC (minutes):	9.55		========
	=======================================	=======================================	========
asin CAR-8b			
t Flow Computations			
	Subarea A	Subarea B	Subarea
Manning's Roughness:	0.04	0.00	
Flow Length (ft):	102.00	0.00	
Slope (%):	0.98	0.00	
2 yr, 24 hr Rainfall (in):	1.50	1.50	
Velocity (ft/sec):	0.25	0.00	
Computed Flow Time (minutes):	6.72	0.00	
el Flow Computations			
	Subarea A	Subarea B	Subarea
Manning's Roughness:	0.01	0.00	
Flow Length (ft):	1419.00	0.00	
Channel Slope (%):	10.29	0.00	
Cross Section Area (ft²):	0.38	0.00	
Wetted Perimeter (ft):	1.58	0.00	
Velocity (ft/sec):	14.09	0.00	
Computed Flow Time (minutes):	1.68	0.00	
Total TOC (minutes):	8.40		

Subbasin CAR-8c

	Flow Computations			
		Subarea A	Subarea B	Subarea
C 0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	102.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	6.72	0.00	
	l Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	1136.00	0.00	
0.00	Channel Slope (%):	10.12	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	13.98	0.00	
0.00	Computed Flow Time (minutes):	1.35	0.00	
	Total TOC (minutes):	8.07		
Subbas Sheet	in CAR-8d Flow Computations			
С		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	300.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.31	0.00	
0.00	Computed Flow Time (minutes):	15.92	0.00	
	l Flow Computations			
C		Subarea A	Subarea B	Subarea

	Manning's Roughness:	0.08	0.00	
	Flow Length (ft):	416.00	0.00	
	Channel Slope (%):	21.36	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	3.30	0.00	
	Computed Flow Time (minutes):	2.10	0.00	
	Total TOC (minutes):	18.03		
sir	CAR-9			
et Fl	ow Computations	Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	300.00	0.00	
	Slope (%):	1.00	0.00	
	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.32	0.00	
	Computed Flow Time (minutes):	15.80	0.00	
	, , , , , , , , , , , , , , , , , , , ,			
	Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
	Flow Length (ft):	463.00	0.00	
	Channel Slope (%):	16.20	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
		17.68	0.00	
	Velocity (ft/sec):	17.00		
	<pre>Velocity (ft/sec): Computed Flow Time (minutes):</pre>	0.44	0.00	

Subbasi	 n O-1 			
	low Computations			
		Subarea A	Subarea B	Subarea
0.0	Manning's Roughness:	0.04	0.00	
00	Flow Length (ft):	80.00	0.00	
00	Slope (%):	1.33	0.00	
00 50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.27	0.00	
0	Computed Flow Time (minutes):	4.90	0.00	
	Flow Computations			
		Subarea A	Subarea B	Subarea
)	Manning's Roughness:	0.01	0.04	
)	Flow Length (ft):	5294.00	1069.00	
	Channel Slope (%):	1.60	7.48	
	Cross Section Area (ft²):	0.38	3660.00	
)	Wetted Perimeter (ft):	1.58	732.00	
)	Velocity (ft/sec):	5.56	29.79	
	Computed Flow Time (minutes):	15.88	0.60	
	Total TOC (minutes):	10.68		
 bbasi	n 0-2a User-Defined TOC override (minutes):			
	n O-2b low Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
)	Manning's Roughness: Flow Length (ft):	0.04	0.00	
)				

1.50	Volenity (ft/noc):	0.32	0.00	
0.00	Velocity (ft/sec):		0.00	
0.00	Computed Flow Time (minutes):	6.37	0.00	
Channe	el Flow Computations			
C		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2136.00	0.00	
	Channel Slope (%):	8.43	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	12.76	0.00	
0.00	Computed Flow Time (minutes):	2.79	0.00	
0.00				
	Total TOC (minutes):	9.16	===========	=======
Subbas	sin O-3 User-Defined TOC override (minutes	5.00		
Subbas	sin 0-3 User-Defined TOC override (minutessin 0-4	5.00		
Subbas	sin 0-3 User-Defined TOC override (minutes sin 0-4		Cubaraa R	Cubarras
Subbas Subbas Sheet	sin 0-3 User-Defined TOC override (minutessin 0-4 Flow Computations	Subarea A	Subarea B	Subarea
Subbas Subbas Sheet	sin 0-3 User-Defined TOC override (minutes sin 0-4 Flow Computations Manning's Roughness:	Subarea A	0.00	Subarea
Subbas Subbas Sheet	sin 0-3 User-Defined TOC override (minutes sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft):	Subarea A 0.04 170.00	0.00	Subarea
Subbas Subbas Sheet	sin 0-3 User-Defined TOC override (minutes sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%):	Subarea A 0.04 170.00 0.29	0.00 0.00 0.00	Subarea
Subbas	User-Defined TOC override (minutes Sin O-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in):	Subarea A 0.04 170.00 0.29 1.50	0.00 0.00 0.00 1.50	Subarea
Subbas Subbas Sheet 	Sin 0-3 User-Defined TOC override (minutes) sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas Subbas Sheet 	User-Defined TOC override (minutes Sin O-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in):	Subarea A 0.04 170.00 0.29 1.50	0.00 0.00 0.00 1.50	Subarea
Subbas Subbas Sheet 	Sin 0-3 User-Defined TOC override (minutes) sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas Subbas Sheet C 0.00 0.00 0.00 1.50 0.00 Channe	User-Defined TOC override (minutes Sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas Subbas Sheet 	User-Defined TOC override (minutes Sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 170.00 0.29 1.50 0.17 16.45	0.00 0.00 0.00 1.50 0.00	
Subbas Subbas Sheet 	User-Defined TOC override (minutes User-Defined TOC override (minutes Sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes): el Flow Computations	Subarea A 0.04 170.00 0.29 1.50 0.17 16.45	0.00 0.00 0.00 1.50 0.00 0.00	
Subbas Subbas Sheet 	User-Defined TOC override (minutes Sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes): el Flow Computations Manning's Roughness:	Subarea A	0.00 0.00 0.00 1.50 0.00 0.00 Subarea B	

0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	10.68	29.81	
0.00	Computed Flow Time (minutes):	2.51	0.49	
=======	Total TOC (minutes):	9.73		=========

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Conc days	Time of entration hh:mm:ss
CAR-10a/Area2	1.50	0.31	0.18	81.000	0	00:05:00
CAR-10b/Area1	1.50	0.13	0.22	73.000	0	00:09:11
CAR-10c	1.50	0.15	0.14	74.000	0	00:05:00
CAR-5	1.50	0.74	13.23	91.000	0	00:06:32
CAR-8a	1.50	0.74	1.72	91.000	0	00:09:33
CAR-8b	1.50	0.45	2.05	85.000	0	00:08:24
CAR-8c	1.50	0.45	5.90	85.000	0	00:08:04
CAR-8d	1.50	0.74	0.27	91.000	0	00:18:01
CAR-9	1.50	0.11	0.18	72.000	0	00:16:13
0-1	1.50	0.38	2.34	83.000	0	00:10:40
0-2a	1.50	0.41	1.14	84.000	0	00:05:00
0-2b	1.50	0.38	1.05	83.000	0	00:09:09
0-3	1.50	0.38	3.98	83.000	0	00:05:00
0-4	1.50	0.54	0.75	87.000	0	00:09:43

Node ID	Average Depth Attained	Maximum Depth Attained	Maximum HGL Attained		of Max irrence	Total Flooded Volume	Total Time Flooded	Retention Time
	ft	ft	ft	days	hh:mm	acre-in	minutes	hh:mm:ss
CAR-24	0.17	0.84	227.34	0	08:00	0	0	0:00:00
CAR-36	0.17	0.84	184.84	0	08:01	0	0	0:00:00
CAR-42	0.15	0.76	123.76	0	08:02	0	0	0:00:00
Jun-A	0.09	0.33	170.33	0	08:06	0	0	0:00:00
Jun-B	0.09	0.33	80.33	0	08:08	0	0	0:00:00
Jun-C	0.15	0.72	60.72	0	08:03	0	0	0:00:00
Jun-CAR10	0.05	0.17	21.17	0	18:06	0	0	0:00:00
Jun-D	0.17	0.68	35.68	0	08:06	0	0	0:00:00
Jun-E	0.35	1.37	21.37	0	08:10	0	0	0:00:00
RioRoadCulvert	0.35	1.37	21.27	0	08:13	0	0	0:00:00

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Peak	lime of Inflow arrence hh:mm	Maximum Flooding Overflow cfs	Occurrence
CAR-24 CAR-36 CAR-42 Jun-A Jun-B Jun-C Jun-CAR10	JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION	19.14 0.00 0.00 6.09 2.05 0.27 0.32	19.14 19.04 19.00 6.09 8.04 27.02 0.32	0 0 0 0 0	08:00 08:01 08:02 08:06 08:07 08:03 18:06	0.00 0.00 0.00 0.00 0.00 0.00	
Jun-D Jun-E RioRoadCulvert	JUNCTION JUNCTION JUNCTION OUTFALL	3.98 0.75 0.00	30.65 31.28 31.14	0 0	08:06 08:10 08:13	0.00	

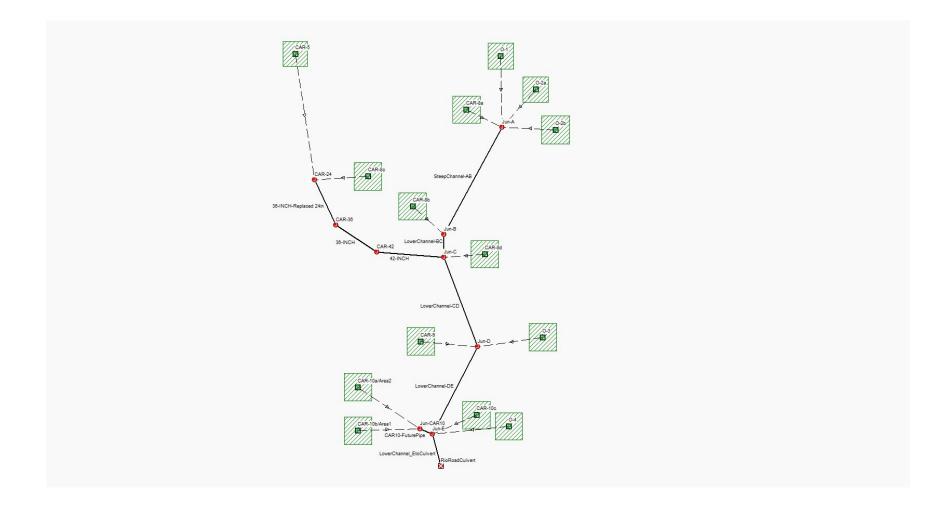
Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	43.15	9.25	31.14
System	43.15	9.25	31.14

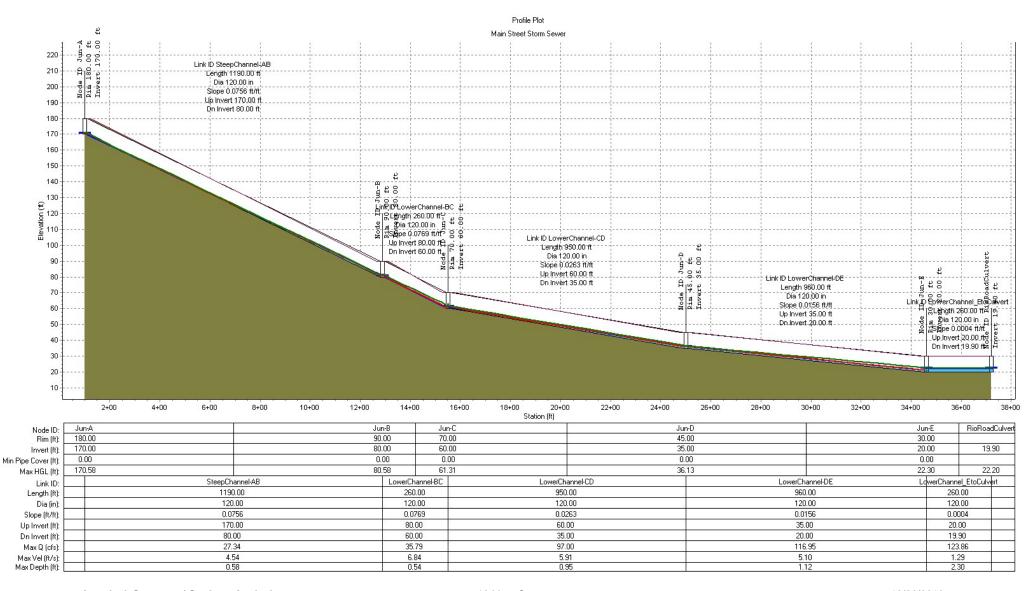
			T	ime of	Maximum	Length	Peak Flow	Design	Ratio of
Ratio of		Reported							
Maximum			Pea.	k F.TOM	Velocity	Factor	during	F,TOM	Maximum
Maximum	Time	Condition	00011	rrence	Attained		Analysis	Canacity	/Design
Flow Surchar	raed		occu.	rrence	Accarned		Anarysis	capacity	/ Design
	- 5		days	hh:mm	ft/sec		cfs	cfs	Flow
Depth mir	nutes		-						
36-INCH		CONDUIT	0	08:02	13.56	1.00	19.00	135.69	0.14
0.25	0 Ca.	lculated							
			0	08:01	11.78	1.00	19.04	111.17	0.17
0.28									
42-INCH		CONDUIT	0	08:03	13.31	1.00	18.97	203.82	0.09
0.21									
CAR10-Futur	_		0	18:06	3.15	1.00	0.32	7.92	0.04
0.14				0 00-	10 0	00 1 0	0 31.14	CO14	4.5
0.01 0.1					13 0.	92 1.0	31.14	0214.	43
LowerChanne					1 71	1 00	8.04	87885.25	0.00
0.03			U	00.00	4.71	1.00	0.04	07003.23	0.00
LowerChanne			0	08:06	4.32	1.00	26.86	51403.88	0.00
0.06			Ŭ		1.02		_0.00	2220.00	3.00
LowerChanne			0	08:10	3.66	1.00	30.44	39609.35	0.00
0.07	0 Ca.	lculated							

SteepChannel-AB CHANNEL 0 08:08 3.14 1.00 6.08 54464.74 0.00 0.03 0 Calculated

******* Highest Flow Instability Indexes All links are stable.

Analysis began on: Wed Dec 26 09:01:54 2018 Analysis ended on: Wed Dec 26 09:01:55 2018 Total elapsed time: 00:00:01





```
Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)
******
Project Description
Analysis Options
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date ..... OCT-15-2018 00:00:00
Ending Date ..... OCT-17-2018 00:00:00
Report Time Step ..... 00:00:10
*****
Element Count
Number of rain gages ..... 1
Number of subbasins ..... 14
Number of nodes ..... 10
Number of links ..... 9
*****
Raingage Summary
Gage Data Data Recording ID Source Type Interval
_____
PebbleBeach 010-year CUMULATIVE 6.00
*****
Subbasin Summary
*****
CAR-10a/Area2 220905.11 0.00 PebbleBeach CAR-10b/Area1 936706.23 0.00 PebbleBeach CAR-10c 549564.77 0.00 PebbleBeach CAR-5 3421768.38 0.00 PebbleBeach CAR-8a 466351.13 0.00 PebbleBeach CAR-8b 1228692.05 0.00 PebbleBeach CAR-8b 3513067.02 0.00 PebbleBeach CAR-8c 3513067.02 0.00 PebbleBeach CAR-8d 84784.75 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach O-1 2106420.50 0.00 PebbleBeach O-2a 749809.98 0.00 PebbleBeach O-2b 911776.34 0.00 PebbleBeach O-3 3162314.26 0.00 PebbleBeach O-4 340813.63 0.00 PebbleBeach
_____
++++++++++
Node Summary
```

************ Node ID	Element Type		tion ft	Elev. ft	A1	ea t²	Inflow	
CAR-24 CAR-36 CAR-42 Jun-A Jun-B Jun-C Jun-CAR10 Jun-D Jun-E RioRoadCulvert	JUNCTION OUTFALL	226 184 123 170 80 60 21	5.50 4.00 3.00 0.00 0.00 0.00 0.00	230.00 190.00 130.00 180.00 90.00 70.00 25.00 45.00 30.00 29.90	4. 4. 0. 0. 0.	00 00 00 00 00 00 00		
********** Link Summary ********* Link	From Node	To Node	E	lement		Length	Slope	Manning's
ID 36-INCH								
36-INCH-Replaced 0.0150 42-INCH CAR10-FuturePipe LowerChannel_Eto	24inCAR-24	CAR-36	S C	CONI	DUIT	1153 0	149.0 3	.6989
0.0250 LowerChannel-BC LowerChannel-CD LowerChannel-DE SteepChannel-AB	Jun-B Jun-C		C			260.0 950.0		0.0250 0.0250
**************************************	mmary							
Link Design ID Flow		Depth/ Diameter		idth				Full Flow Hydraulic
Capacity							Area	Radius
cfs		ft		ft			ft²	ft
135.69	CIRCULAR	3.00		3.00		1	7.07	0.75
36-INCH-Replaced 0.75 111.17			.00	3.0	00		1	7.07
42-INCH 203.82	CIRCULAR			3.50		_		0.88
CAR10-FuturePipe				1.25	- 00	1	1.23	
LowerChannel_Eto 4.99 6214.43					5.00	1	1 225 00	
LowerChannel-BC 87885.25 LowerChannel-CD				5.00		1	1825.00 1825.00	
51403.88 LowerChannel-DE				5.00		1	1825.00	
39609.35 SteepChannel-AB				5.00		1	1825.00	
occoponamici in		20.00	30			-	1020.00	1.00

54464.74

	Area	Soil	
Soil/Surface Description		Group	CN
Composite Area & Weighted CN	1228692.05		85.00
Subbasin CAR-8c			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	
Composite Area & Weighted CN	3513067.02		85.00
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00
Subbasin 0-1			
	7	C1	
Soil/Surface Description		Soil Group	
Composite Area & Weighted CN	2106420.50		83.00
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00
Subbasin 0-2b			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00
Subbasin 0-3			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	CN
Composite Area & Weighted CN	3162314.26		83.00
Subbasin 0-4			
Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63		87.00

Subbasin CAR-10a/Area2			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	220905.11 220905.11		0.72 0.72
Subbasin CAR-10b/Area1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	936706.23 936706.23	-	0.72 0.72
Subbasin CAR-10c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	549564.77 549564.77		0.72 0.72
Subbasin CAR-5			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	4718448.95 4718448.95	-	0.72 0.72
Subbasin CAR-8a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	466351.13 466351.13	-	0.72 0.72
Subbasin CAR-8b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	1228692.05 1228692.05	-	0.72 0.72
Subbasin CAR-8c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

- Composite Area & Weighted Runoff Coeff.	3513067.02 3513067.02	-	0.72 0.72
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	84784.75 84784.75	-	0.72 0.72
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	834219.64 834219.64	_	0.72 0.72
Subbasin 0-1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	2106420.50 2106420.50	-	0.72 0.72
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	
Composite Area & Weighted Runoff Coeff.	749809.98 749809.98	-	0.72 0.72
Subbasin O-2b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	911776.34 911776.34	-	0.72 0.72
Subbasin 0-3			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	3162314.26 3162314.26	-	0.72 0.72
Subbasin 0-4			
Soil/Surface Description		Soil Group	
- Composite Area & Weighted Runoff Coeff.	340813.63 340813.63		0.72 0.72

```
SCS TR-55 Time of Concentration Computations Report
  Sheet Flow Equation
           Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))
           Where:
           Tc = Time of Concentration (hrs)
           n = Manning's Roughness
           Lf = Flow Length (ft)
           P = 2 yr, 24 hr Rainfall (inches)
           Sf = Slope (ft/ft)
  Shallow Concentrated Flow Equation
           V = 16.1345 * (Sf^0.5)  (unpaved surface)
           V = 20.3282 * (Sf^0.5) (paved surface)
           V = 15.0 * (Sf^0.5) (grassed waterway surface)
           V = 10.0 * (Sf^0.5)  (grassed waterway surface)

V = 10.0 * (Sf^0.5)  (nearly bare & untilled surface)

V = 9.0 * (Sf^0.5)  (cultivated straight rows surface)
           V = 7.0 * (Sf^0.5) (short grass pasture surface)
           V = 5.0 * (Sf^0.5) (woodland surface)

V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
           Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           V = Velocity (ft/sec)
Sf = Slope (ft/ft)
  Channel Flow Equation
           V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n
           R = Aq / Wp

Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           R = Hydraulic Radius (ft)
           Aq = \overline{Flow} Area (ft^2)
           Wp = Wetted Perimeter (ft)
           V = Velocity (ft/sec)
           Sf = Slope (ft/ft)
           n = Manning's Roughness
  Subbasin CAR-10a/Area2
  Sheet Flow Computations
                                                        Subarea A
                                                                             Subarea B
                                                                                                     Subarea
                                                             0.04
                                                                                     0.00
         Manning's Roughness:
                                                             65.00
                                                                                     0.00
          Flow Length (ft):
0.00
```

С

0.00	Slope (%):	0.77	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.21	0.00	
0.00	Computed Flow Time (minutes):	5.16	0.00	
Channel	Flow Computations			
С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	1180.00	884.00	
0.00	Channel Slope (%):	8.05	7.49	
0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	12.47	29.81	
0.00	Computed Flow Time (minutes):	1.58	0.49	
=======	Total TOC (minutes):	3.62	===========	=============

Subbasin CAR-10b/Area1

Sheet Flow Computations

С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	111.00	0.00	
0.00	Slope (%):	1.80	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.33	0.00	
0.00		5.64	0.00	
0.00	Computed Flow Time (minutes):	5.04	0.00	
Channel	Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2186.00	0.00	
0.00	Channel Slope (%):	5.43	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	cross section area (it).	0.30	0.00	

0.00	<pre>etted Perimeter (ft): elocity (ft/sec):</pre>	1.58	0.00	
	elocity (it/sec):			
		10.24	0.00	
0.00	omputed Flow Time (minutes):	3.56	0.00	
		:=========		
T	otal TOC (minutes):	9.19		
========		:========:		
Subbasin (CAR-10c			
Sheet Flo	w Computations			
		Subarea A	Subarea B	Subarea
	anning's Roughness:	0.04	0.00	
	low Length (ft):	106.00	0.00	
0.00 S	lope (%):	0.94	0.00	
	yr, 24 hr Rainfall (in):	1.50	1.50	
1.50 V	Telocity (ft/sec):	0.25	0.00	
	omputed Flow Time (minutes):	7.04	0.00	
0.00				
Channel F	low Computations			
С		Subarea A	Subarea B	Subarea
0.00	anning's Roughness:	0.01	0.04	
0.00	low Length (ft):	954.00	884.00	
0.00	hannel Slope (%):	8.91	7.49	
	ross Section Area (ft²):	0.75	3660.00	
	etted Perimeter (ft):	1.58	732.00	
	elocity (ft/sec):	20.82	29.81	
	omputed Flow Time (minutes):	0.76	0.49	
		:==========		========
T	otal TOC (minutes):	4.15		
=======				========
Subbasin				
Sheet Flo	w Computations			
Sheet Flor	w Computations	Subarea A	Subarea B	Subarea

Ma	anning's Roughness:	0.04	0.00	
	low Length (ft):	108.00	0.00	
	lope (%):	0.93	0.00	
	yr, 24 hr Rainfall (in):	1.50	1.50	
	elocity (ft/sec):	0.25	0.00	
	omputed Flow Time (minutes):	7.18	0.00	
	low Computations			
		Subarea A	Subarea B	Subar
M	annianta Daumhaana			Subar
	anning's Roughness:	0.01	0.01	
	low Length (ft):		2541.00	
	hannel Slope (%):	6.90	6.49	
Ci	ross Section Area (ft²):	0.38	3.14	
We	etted Perimeter (ft):	1.58	6.28	
Ve	elocity (ft/sec):	11.54	18.39	
Co	omputed Flow Time (minutes):	3.59	2.30	
T	otal TOC (minutes):	6.54		
T(otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
To	otal TOC (minutes): CAR-8a w Computations	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
bbasin (eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness:	6.54 Subarea A 0.04	Subarea B	
eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft):	6.54 Subarea A 0.04 108.00	Subarea B 0.00 0.00	
bbasin (eet Flow F: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%):	Subarea A 0.04 108.00 1.85	Subarea B 0.00 0.00 0.00	
bbasin (eet Flow S. 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in):	Subarea A 0.04 108.00 1.85 1.50	Subarea B 0.00 0.00 0.00 1.50	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33	Subarea B 0.00 0.00 0.00 1.50 0.00	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	Subar
bbasin (eet Flow F: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes): low Computations	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B	Subar
bbasin (eet Flor S: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	

	Channel Slope (%):	1.37	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	5.14	0.00	
	Computed Flow Time (minutes):	4.10	0.00	
-	Total TOC (minutes):	9.55	=======================================	
S	in CAR-8b Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	102.00	0.00	
	Slope (%):	0.98	0.00	
	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.25	0.00	
	Computed Flow Time (minutes):	6.72	0.00	
	l Flow Computations			
_		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
	Flow Length (ft):	1419.00	0.00	
	Channel Slope (%):	10.29	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	14.09	0.00	
	Computed Flow Time (minutes):	1.68	0.00	
		8.40		
	= \= /	0.10		

Subbasin CAR-8c

Sheet	Flow Computations			
C		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	102.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	6.72	0.00	
Chann	el Flow Computations			
C		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	1136.00	0.00	
0.00	Channel Slope (%):	10.12	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	13.98	0.00	
0.00	Computed Flow Time (minutes):	1.35	0.00	
	Total TOC (minutes):	8.07		
Subba	sin CAR-8d Flow Computations			
С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	300.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.31	0.00	
0.00	Computed Flow Time (minutes):	15.92	0.00	
Chann	el Flow Computations			
C		Subarea A	Subarea B	Subarea

Man	ning's Roughness:	0.08	0.00	
	w Length (ft):	416.00	0.00	
Cha	nnel Slope (%):	21.36	0.00	
	ss Section Area (ft²):	0.38	0.00	
	ted Perimeter (ft):	1.58	0.00	
0 Vel 0	ocity (ft/sec):	3.30	0.00	
	puted Flow Time (minutes):	2.10	0.00	
Tot	al TOC (minutes):	18.03		
bbasin CA	 R-9			
eet Flow	Computations	Subarea A	Subarea B	Subarea
Mar	ning's Roughness:	0.04	0.00	
	w Length (ft):	300.00	0.00	
	pe (%):	1.00	0.00	
	r, 24 hr Rainfall (in):	1.50	1.50	
_	ocity (ft/sec):	0.32	0.00	
	puted Flow Time (minutes):	15.80	0.00	
	w Computations			
		Subarea A	Subarea B	Subarea
Man	ning's Roughness:	0.01	0.00	
Flc	w Length (ft):	463.00	0.00	
Cha	nnel Slope (%):	16.20	0.00	
Crc	ss Section Area (ft²):	0.38	0.00	
Wet	ted Perimeter (ft):	1.58	0.00	
Vel	ocity (ft/sec):	17.68	0.00	
Com	puted Flow Time (minutes):	0.44	0.00	
	al TOC (minutes):	16.23		=======

Subbas	sin O-1			
	Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	80.00	0.00	
0.00	Slope (%):	1.33	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.27	0.00	
0.00	Computed Flow Time (minutes):	4.90	0.00	
Channe	el Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	5294.00	1069.00	
	Channel Slope (%):	1.60	7.48	
0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	5.56	29.79	
0.00	Computed Flow Time (minutes):	15.88	0.60	
	Total TOC (minutes):	10.68		
 Subbas	sin O-2a 			
	sin O-2b			
	Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	123.00	0.00	
0.00	Slope (%):	1.63	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	

1.50				
0.00	Velocity (ft/sec):	0.32	0.00	
	Computed Flow Time (minutes):	6.37	0.00	
0.00 Chann	el Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2136.00	0.00	
0.00	Channel Slope (%):	8.43	0.00	
0.00	Cross Section Area (ft ²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	12.76	0.00	
0.00	Computed Flow Time (minutes):	2.79	0.00	
0.00	(
======	Total TOC (minutes):	9.16		========
Subba	User-Defined TOC override (minutes): 5.00		
	Flow Computations			
С		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	170.00	0.00	
0.00	Slope (%):	0.29	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.17	0.00	
0.00	Computed Flow Time (minutes):	16.45	0.00	
Chann	el Flow Computations			
С		Subarea A	Subarea B	Subarea
0 0 0	Manning's Roughness:	Subarea A	Subarea B 0.04	Subarea
0.00	Manning's Roughness: Flow Length (ft):			Subarea
0.00		0.01	0.04	Subarea

0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	<pre>Velocity (ft/sec):</pre>	10.68	29.81	
0.00	Computed Flow Time (minutes):	2.51	0.49	
=======	Total TOC (minutes):	9.73		=======

Node ID	Average Depth Attained	Maximum Depth Attained	Maximum HGL Attained		of Max irrence	Total Flooded Volume	Total Time Flooded	Retention Time
	ft	ft	ft	days	hh:mm	acre-in	minutes	hh:mm:ss
CAR-24	0.28	1.59	228.09	0	08:00	0	0	0:00:00
CAR-36	0.28	1.59	185.59	0	08:00	0	0	0:00:00
CAR-42	0.26	1.41	124.41	0	08:01	0	0	0:00:00
Jun-A	0.14	0.58	170.58	0	08:00	0	0	0:00:00
Jun-B	0.14	0.58	80.58	0	08:02	0	0	0:00:00
Jun-C	0.25	1.31	61.31	0	08:02	0	0	0:00:00
Jun-CAR10	0.12	0.55	21.55	0	08:00	0	0	0:00:00
Jun-D	0.27	1.13	36.13	0	08:03	0	0	0:00:00
Jun-E	0.55	2.30	22.30	0	08:05	0	0	0:00:00
RioRoadCulvert	0.55	2.30	22.20	0	08:07	0	0	0:00:00

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Peak	lime of Inflow arrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days hh:mm
CAR-24 CAR-36	JUNCTION JUNCTION	61.07 0.00	61.07 60.96	0	08:00 08:00	0.00	
CAR-42	JUNCTION	0.00	60.89	0	08:01	0.00	
Jun-A	JUNCTION	27.71	27.71	0	08:00	0.00	
Jun-B	JUNCTION	8.68	35.80	0	08:02	0.00	
Jun-C	JUNCTION	0.75	97.31	0	08:02	0.00	
Jun-CAR10	JUNCTION	3.21	3.21	0	08:00	0.00	
Jun-D	JUNCTION	21.48	117.23	0	08:03	0.00	
Jun-E	JUNCTION	4.21	124.10	0	08:05	0.00	
RioRoadCulvert	OUTFALL	0.00	123.86	0	08:07	0.00	

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	47.31	25.41	123.86
System	47.31	25.41	123.86

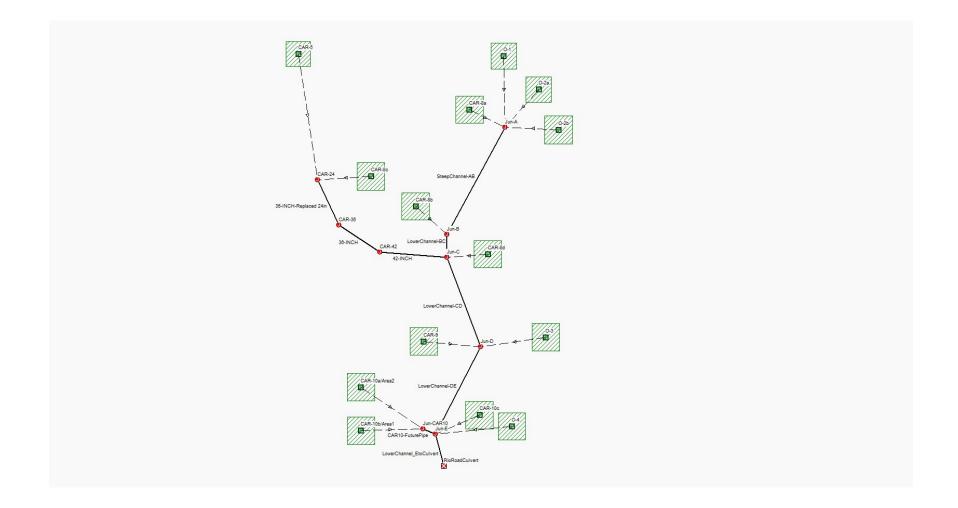
Link ID			T	ime of	Maximum	Length	Peak Flow	Design	Ratio of
Ratio of	Total	Reported							
			Peal	c Flow	Velocity	Factor	during	Flow	Maximum
Maximum	Time	Condition	0000		7++2-12-0		Analysis	Conneitu	/Design
Flow Surchar	aed		occu.	Tence	Accarned		Allalysis	Capacity	/ Design
11011 00101101	gou		davs	hh:mm	ft/sec		cfs	cfs	Flow
Depth min	utes		-						
36-INCH		CONDUIT	0	08:01	18.72	1.00	60.89	135.69	0.45
0.47			Ü	00.01	10.72	1.00	00.03	100.03	0.10
36-INCH-Rep	laced 2	4in CONDUIT	0	08:00	16.14	1.00	60.96	111.17	0.55
0.53	0 Ca.	lculated							
42-INCH		CONDUIT	0	08:02	18.53	1.00	60.82	203.82	0.30
0.37									
CAR10-Futur	_		0	08:00	6.11	1.00	3.20	7.92	0.40
0.44									_
		lvert CHANNEL		0 08:	07 1.	29 1.00	0 123.86	6214.4	3
0.02 0.2				00 00	6.04	1 00	25 70	07005 05	0.00
LowerChanne			U	08:02	6.84	1.00	35.79	87885.25	0.00
0.05			0	08:04	5.91	1 00	97.00	51403.88	0.00
LowerChanne			U	00:04	5.91	1.00	97.00	31403.88	0.00
LowerChanne			Ω	08:05	5.10	1.00	116.95	39609.35	0.00
0.11			U	00.00	3.10	1.00	110.90	3,009.33	0.00
· · · ·	o ca	10414004							

SteepChannel-AB CHANNEL 0 08:02 4.54 1.00 27.34 54464.74 0.00 0.06 0 Calculated

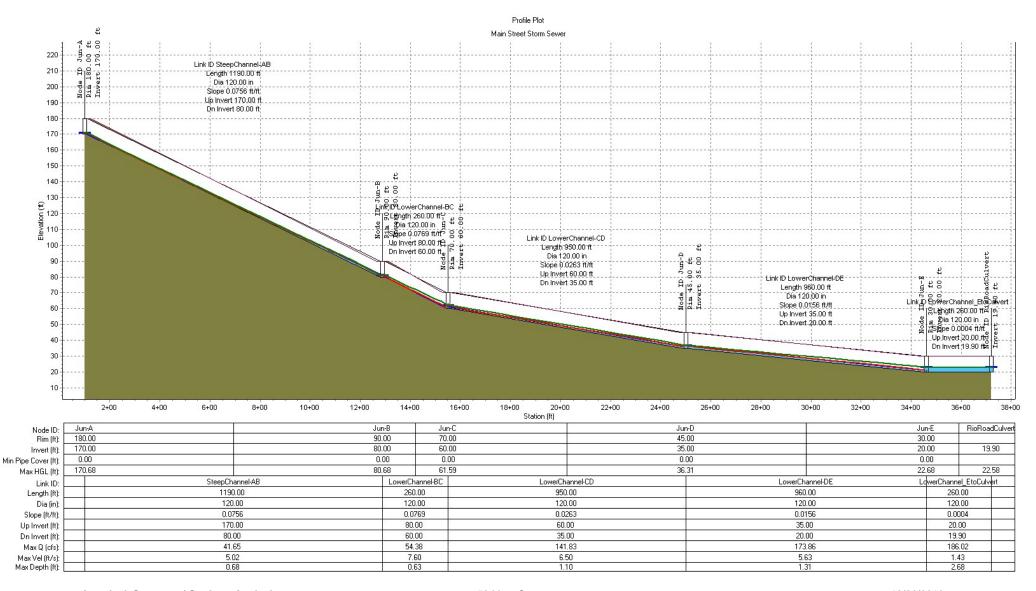
******* Highest Flow Instability Indexes All links are stable.

Analysis began on: Wed Dec 26 08:57:44 2018 Analysis ended on: Wed Dec 26 08:57:45 2018 Total elapsed time: 00:00:01

18-028 Mission Trail Creek Assessment Waterways Consulting, Inc.



18-028 Mission Trail Creek Assessment Waterways Consulting, Inc.



Autodesk® Storm and							
*****	*						
Project Description							
File Name	18-	028 SSA-Sto	rm Modelin	g-Upsize	d-181221.SPF		

Analysis Options							
Flow Units							
*********** Element Count *********							
Number of rain gag Number of subbasin Number of nodes Number of links	s 14 10						

Raingage Summary							

Gage ID	Data Source		ta R				
ID	Source	тy	pe		min		
PebbleBeach	050-year	CU	MULATIVE	6.00			

Subbasin Summary							

Subbasin		Imperv.	Raingage				
ID		Area %					
CAD 102/Ama22	220005 11			a ah			
CAR-10a/Area2 CAR-10b/Area1	220905.11 936706.23 549564.77	0.00	PebbleBe	ach			
CAR-10c	549564.77	0.00	PebbleBe	ach			
CAR-5	3421768.38	0.00	PebbleBe	ach			
CAR-8a	466351.13	0.00	PebbleBe				
CAR-8b	1228692.05	0.00	PebbleBe				
			DalalalaDa	ach			
CAR-8c	3513067.02	0.00	PebbleBe				
CAR-8d	3513067.02 84784.75	0.00	PebbleBe	ach			
CAR-8d CAR-9	3513067.02	0.00	PebbleBe PebbleBe	ach ach			
CAR-8d	3513067.02 84784.75 834219.64	0.00	PebbleBe	ach ach ach			
CAR-8d CAR-9 O-1 O-2a O-2b	3513067.02 84784.75 834219.64 2106420.50 749809.98 911776.34	0.00 0.00 0.00 0.00	PebbleBe PebbleBe PebbleBe PebbleBe PebbleBe	ach ach ach ach ach			
CAR-8d CAR-9 O-1 O-2a O-2b O-3	3513067.02 84784.75 834219.64 2106420.50 749809.98 911776.34 3162314.26	0.00 0.00 0.00 0.00 0.00	PebbleBe PebbleBe PebbleBe PebbleBe PebbleBe	ach ach ach ach ach			
CAR-8d CAR-9 O-1 O-2a O-2b	3513067.02 84784.75 834219.64 2106420.50 749809.98 911776.34	0.00 0.00 0.00 0.00	PebbleBe PebbleBe PebbleBe PebbleBe PebbleBe	ach ach ach ach ach			
CAR-8d CAR-9 O-1 O-2a O-2b O-3	3513067.02 84784.75 834219.64 2106420.50 749809.98 911776.34 3162314.26	0.00 0.00 0.00 0.00 0.00	PebbleBe PebbleBe PebbleBe PebbleBe PebbleBe	ach ach ach ach ach			
CAR-8d CAR-9 O-1 O-2a O-2b O-3	3513067.02 84784.75 834219.64 2106420.50 749809.98 911776.34 3162314.26	0.00 0.00 0.00 0.00 0.00	PebbleBe PebbleBe PebbleBe PebbleBe PebbleBe	ach ach ach ach ach			

************ Node ID	Element Type			ft	ft²		
CAR-24 CAR-36 CAR-42 Jun-A Jun-B Jun-C Jun-CAR10 Jun-D Jun-E RioRoadCulvert	JUNCTION	226 184 123 170 80	23 .00 19 .00 13 .00 18 .00 9	0.00 0.00 0.00 0.00 0.00	4.00 4.00 4.00 0.00 0.00		
*********** Link Summary ********* Link	From Node	To Node	Elem	ent	Length	Slope	Manning's
36-INCH 36-INCH-Replaced 0.0150	CAR-36 24inCAR-24	CAR-42 CAR-36	COND	UIT CONDUIT	1107.0	5.5104 149.0 3.	0.0150 .6989
42-INCH CAR10-FuturePipe LowerChannel_Eto 0.0250	CAR-42 Jun-CAR10 CulvertJun-E	Jun-C Jun-E RioF	COND COND coadCulver	UIT UIT t CHANNE	1153.0 50.0	5.4640 2.0000 260.0	0.0150 0.0150 0.0385
LowerChannel-BC LowerChannel-CD LowerChannel-DE SteepChannel-AB	Jun-B Jun-C Jun-D Jun-A	Jun-C Jun-D Jun-E Jun-B	CHAN CHAN CHAN CHAN	NEL NEL NEL	260.0 950.0 960.0 1190.0	7.6923 2.6316 1.5625 7.5630	0.0250 0.0250 0.0250 0.0400
**************************************	mmary						
*************** Link		Depth/	Widt	h	No. of	Cross	Full Flow
Design ID		Diameter		В	arrels	Sectional	Hydraulic
Flow							Radius
Capacity			_				
cfs		ft	f	t		ft²	ft
36-INCH 135.69	CIRCULAR	3.00	3.0	0	1	7.07	0.75
36-INCH-Replaced 0.75 111.17	24in CIRCULAR	3.	00	3.00		1	7.07
42-INCH	CIRCULAR	3.50	3.5	0	1	9.62	0.88
203.82 CAR10-FuturePipe 7.92	CIRCULAR	1.25	1.2	5	1	1.23	0.31
LowerChannel_Eto 4.99 6214.43	Culvert TRIANGU	LAR 1	0.00	365.00		1 1	825.00
LowerChannel-BC 87885.25	TRIANGULAR	10.00	365.0	0	1	1825.00	4.99
LowerChannel-CD 51403.88	TRIANGULAR	10.00	365.0	0	1	1825.00	4.99
LowerChannel-DE 39609.35	TRIANGULAR	10.00	365.0	0	1	1825.00	4.99
SteepChannel-AB	TRIANGULAR	10.00	365.0	0	1	1825.00	4.99

54464.74

******	Volume	Depth		
Runoff Quantity Continuity *********	acre-ft	inches		
Total Precipitation	122.282	3.450		
Surface Runoff	68.200 0.000	1.924		
Continuity Effor (%)	0.000			
******	Volume	Volume		
Flow Routing Continuity	acre-ft	Mgallons		
External Inflow	0.000	0.000		
External Outflow	68.168	22.213		
Initial Stored Volume Final Stored Volume	0.000	0.000		
Continuity Error (%)	0.000	0.000		

Composite Curve Number Computa	******			
Subbasin CAR-10a/Area2				
0.11/0.5		Area	Soil	917
Soil/Surface Description		(ft²)	Group 	CN
Composite Area & Weighted CN		220905.11		81.00
Subbasin CAR-10b/Area1				
Soil/Surface Description		Area (ft²)	Soil Group	CN
Composite Area & Weighted CN		936706.23		73.00
Subbasin CAR-10c				
		7	0-11	
Soil/Surface Description		Area (ft²)	Soil Group	CN
Composite Area & Weighted CN		549564.77		74.00
Subbasin CAR-5				
		Area	Soil	
Soil/Surface Description		(ft²)	Group	CN
Composite Area & Weighted CN		3421768.38		91.00
Subbasin CAR-8a				
0.13/0.5		Area		
Soil/Surface Description		(ft²)	Group 	CN
Composite Area & Weighted CN		466351.13		91.00
Cubbasia CAD Ob				
Subbasin CAR-8b				

	Area	Soil	
Soil/Surface Description		Group	CN
Composite Area & Weighted CN	1228692.05		85.00
Subbasin CAR-8c			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	
Composite Area & Weighted CN	3513067.02		85.00
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00
Subbasin 0-1			
	7	C1	
Soil/Surface Description		Soil Group	
Composite Area & Weighted CN	2106420.50		83.00
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00
Subbasin 0-2b			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00
Subbasin 0-3			
	Area	Soil	
Soil/Surface Description	(ft²)	Group	CN
Composite Area & Weighted CN	3162314.26		83.00
Subbasin 0-4			
Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63		87.00

Subbasin CAR-10a/Area2			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	220905.11 220905.11		0.72 0.72
Subbasin CAR-10b/Area1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	936706.23 936706.23	-	0.72 0.72
Subbasin CAR-10c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	549564.77 549564.77		0.72 0.72
Subbasin CAR-5			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	4718448.95 4718448.95	-	0.72 0.72
Subbasin CAR-8a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	466351.13 466351.13	-	0.72 0.72
Subbasin CAR-8b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	1228692.05 1228692.05	-	0.72 0.72
Subbasin CAR-8c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

- Composite Area & Weighted Runoff Coeff.	3513067.02 3513067.02	-	0.72 0.72
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	84784.75 84784.75	-	0.72 0.72
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	834219.64 834219.64	-	0.72 0.72
Subbasin O-1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	2106420.50 2106420.50	-	0.72 0.72
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	749809.98 749809.98	-	0.72 0.72
Subbasin O-2b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	911776.34 911776.34	-	0.72 0.72
Subbasin O-3			
Soil/Surface Description		Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	3162314.26 3162314.26	-	0.72 0.72
Subbasin O-4			
Soil/Surface Description		Soil Group	Runoff Coeff.

```
SCS TR-55 Time of Concentration Computations Report
  Sheet Flow Equation
           Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))
           Where:
           Tc = Time of Concentration (hrs)
           n = Manning's Roughness
           Lf = Flow Length (ft)
           P = 2 yr, 24 hr Rainfall (inches)
           Sf = Slope (ft/ft)
  Shallow Concentrated Flow Equation
           V = 16.1345 * (Sf^0.5)  (unpaved surface)
           V = 20.3282 * (Sf^0.5) (paved surface)
           V = 15.0 * (Sf^0.5) (grassed waterway surface)
           V = 10.0 * (Sf^0.5)  (grassed waterway surface)

V = 10.0 * (Sf^0.5)  (nearly bare & untilled surface)

V = 9.0 * (Sf^0.5)  (cultivated straight rows surface)
           V = 7.0 * (Sf^0.5) (short grass pasture surface)
           V = 5.0 * (Sf^0.5) (woodland surface)

V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
           Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           V = Velocity (ft/sec)
Sf = Slope (ft/ft)
  Channel Flow Equation
           V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n
           R = Aq / Wp

Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           R = Hydraulic Radius (ft)
           Aq = \overline{Flow} Area (ft^2)
           Wp = Wetted Perimeter (ft)
           V = Velocity (ft/sec)
           Sf = Slope (ft/ft)
           n = Manning's Roughness
  Subbasin CAR-10a/Area2
  Sheet Flow Computations
                                                        Subarea A
                                                                             Subarea B
                                                                                                     Subarea
                                                             0.04
                                                                                     0.00
         Manning's Roughness:
                                                             65.00
                                                                                     0.00
          Flow Length (ft):
0.00
```

С

0.00	Slope (%):	0.77	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.21	0.00	
0.00	Computed Flow Time (minutes):	5.16	0.00	
Channel	Flow Computations			
С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	1180.00	884.00	
0.00	Channel Slope (%):	8.05	7.49	
0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	12.47	29.81	
0.00	Computed Flow Time (minutes):	1.58	0.49	
0.00				
=======	Total TOC (minutes):	3.62	===========	=========

Subbasin CAR-10b/Area1

Sheet Flow Computations

С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	111.00	0.00	
0.00	Slope (%):	1.80	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.33	0.00	
0.00	Computed Flow Time (minutes):	5.64	0.00	
0.00	compaced from from (managed),	0.01	0.00	
Channe	l Flow Computations			
~		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2186.00	0.00	
0.00	Channel Slope (%):	5.43	0.00	
0.00	Cross Section Area (ft ²):	0.38	0.00	
0.00	, , , ,			

0.00	<pre>etted Perimeter (ft): elocity (ft/sec):</pre>	1.58	0.00	
	elocity (it/sec):			
		10.24	0.00	
0.00	omputed Flow Time (minutes):	3.56	0.00	
		:=========		
T	otal TOC (minutes):	9.19		
========		:========:		
Subbasin (CAR-10c			
Sheet Flo	w Computations			
		Subarea A	Subarea B	Subarea
	anning's Roughness:	0.04	0.00	
	low Length (ft):	106.00	0.00	
0.00 S	lope (%):	0.94	0.00	
	yr, 24 hr Rainfall (in):	1.50	1.50	
1.50 V	Telocity (ft/sec):	0.25	0.00	
	omputed Flow Time (minutes):	7.04	0.00	
0.00				
Channel F	low Computations			
С		Subarea A	Subarea B	Subarea
0.00	anning's Roughness:	0.01	0.04	
0.00	low Length (ft):	954.00	884.00	
0.00	hannel Slope (%):	8.91	7.49	
	ross Section Area (ft²):	0.75	3660.00	
	etted Perimeter (ft):	1.58	732.00	
	elocity (ft/sec):	20.82	29.81	
	omputed Flow Time (minutes):	0.76	0.49	
		:==========		========
T	otal TOC (minutes):	4.15		
=======				========
Subbasin				
Sheet Flo	w Computations			
Sheet Flor	w Computations	Subarea A	Subarea B	Subarea

Ma	anning's Roughness:	0.04	0.00	
	low Length (ft):	108.00	0.00	
	lope (%):	0.93	0.00	
	yr, 24 hr Rainfall (in):	1.50	1.50	
	elocity (ft/sec):	0.25	0.00	
	omputed Flow Time (minutes):	7.18	0.00	
	low Computations			
		Subarea A	Subarea B	Subar
M	annianta Daumhaana			Subar
	anning's Roughness:	0.01	0.01	
	low Length (ft):		2541.00	
	hannel Slope (%):	6.90	6.49	
Ci	ross Section Area (ft²):	0.38	3.14	
We	etted Perimeter (ft):	1.58	6.28	
Ve	elocity (ft/sec):	11.54	18.39	
Co	omputed Flow Time (minutes):	3.59	2.30	
T	otal TOC (minutes):	6.54		
T(otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
To	otal TOC (minutes): CAR-8a w Computations	6.54		
To	otal TOC (minutes): CAR-8a w Computations	6.54 Subarea A	Subarea B	
bbasin (eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness:	6.54 Subarea A 0.04	Subarea B	
eet Flow	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft):	6.54 Subarea A 0.04 108.00	Subarea B 0.00 0.00	
bbasin (eet Flow F: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%):	Subarea A 0.04 108.00 1.85	Subarea B 0.00 0.00 0.00	
bbasin (eet Flow S. 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in):	Subarea A 0.04 108.00 1.85 1.50	Subarea B 0.00 0.00 0.00 1.50	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33	Subarea B 0.00 0.00 0.00 1.50 0.00	
bbasin (eet Flor S: 2	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	Subar
bbasin (eet Flow F: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes): low Computations	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B	Subar
bbasin (eet Flor S: 2 Ve Co annel F:	otal TOC (minutes): CAR-8a w Computations anning's Roughness: low Length (ft): lope (%): yr, 24 hr Rainfall (in): elocity (ft/sec): omputed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	

	Channel Slope (%):	1.37	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	5.14	0.00	
	Computed Flow Time (minutes):	4.10	0.00	
	Total TOC (minutes):	9.55		
as	sin CAR-8b			
et 	Flow Computations	Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	Subarea
	Flow Length (ft):	102.00	0.00	
	Slope (%):	0.98	0.00	
	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.25	0.00	
	Computed Flow Time (minutes):	6.72	0.00	
	compaced flow fine (minutes).	0.72	0.00	
16	el Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
	Flow Length (ft):	1419.00	0.00	
	Channel Slope (%):	10.29	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	14.09	0.00	
	Computed Flow Time (minutes):	1.68	0.00	
		.==========		

Subbasin CAR-8c

Sheet	Flow Computations			
C		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	102.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	6.72	0.00	
Chann	el Flow Computations			
C		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	1136.00	0.00	
0.00	Channel Slope (%):	10.12	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	13.98	0.00	
0.00	Computed Flow Time (minutes):	1.35	0.00	
	Total TOC (minutes):	8.07		
Subba	sin CAR-8d Flow Computations			
С		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	300.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.31	0.00	
0.00	Computed Flow Time (minutes):	15.92	0.00	
Chann	el Flow Computations			
C		Subarea A	Subarea B	Subarea

Manning's D	Roughness:	0.08	0.00	
Flow Length	ı (ft):	416.00	0.00	
Channel Slo	ope (%):	21.36	0.00	
	ion Area (ft²):	0.38	0.00	
Wetted Per	imeter (ft):	1.58	0.00	
Velocity (:	ft/sec):	3.30	0.00	
Computed F	low Time (minutes):	2.10	0.00	
Total TOC	(minutes):	18.03		
asin CAR-9	-ions			
		Subarea A	Subarea B	Subarea
Manning's B	Roughness:	0.04	0.00	
Flow Length	n (ft):	300.00	0.00	
Slope (%):		1.00	0.00	
	r Rainfall (in):	1.50	1.50	
Velocity (:	ft/sec):	0.32	0.00	
Computed F	low Time (minutes):	15.80	0.00	
nel Flow Comput				
		Subarea A	Subarea B	Subarea
Manning's D	Roughness:	0.01	0.00	
Flow Length	n (ft):	463.00	0.00	
Channel Slo	ope (%):	16.20	0.00	
Cross Sect	ion Area (ft²):	0.38	0.00	
Wetted Per:	imeter (ft):	1.58	0.00	
Velocity (ft/sec):	17.68	0.00	
Computed F	low Time (minutes):	0.44	0.00	
Total TOC	(minutes):	16.23		

Subbasir	 n 0-1			
	low Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
.00	Flow Length (ft):	80.00	0.00	
00	Slope (%):	1.33	0.00	
50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.27	0.00	
0	Computed Flow Time (minutes):	4.90	0.00	
Channel	Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.04	
)	Flow Length (ft):	5294.00	1069.00	
	Channel Slope (%):	1.60	7.48	
	Cross Section Area (ft²):	0.38	3660.00	
l I	Wetted Perimeter (ft):	1.58	732.00	
	Velocity (ft/sec):	5.56	29.79	
	Computed Flow Time (minutes):	15.88	0.60	
	Total TOC (minutes):	10.68		
 ıbbasir				
	User-Defined TOC override (minutes):	5.00		
ıbbasir	 n 0-2b 			
heet Fl	low Computations			
		Subarea A	Subarea B	Subarea
ı	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	123.00	0.00	
	Slope (%):	1.63	0.00	

0.00	Velocity (ft/sec):	0.32	0.00	
0.00	Computed Flow Time (minutes):	6.37	0.00	
Channe	el Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2136.00	0.00	
0.00	Channel Slope (%):	8.43	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	<pre>Velocity (ft/sec):</pre>	12.76	0.00	
0.00	Computed Flow Time (minutes):	2.79	0.00	
0.00				
	Total TOC (minutes):	9.16		
	User-Defined TOC override (minutes	5.00		
Subbas	sin O-4	5.00		
Subbas	sin O-4	5): 5.00		
Subbas Sheet	sin O-4		Ouhawaa R	Quib a va a
Subbas Sheet	sin O-4 Flow Computations	Subarea A	Subarea B	Subarea
Subbas Sheet 	sin O-4 Flow Computations Manning's Roughness:	Subarea A	0.00	Subarea
Subbas Sheet 	sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft):	Subarea A 0.04 170.00	0.00	Subarea
Subbas Sheet C C	sin O-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%):	Subarea A 0.04 170.00 0.29	0.00 0.00 0.00	Subarea
SubbasC SheetC C 0.00 0.00	Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in):	Subarea A 0.04 170.00 0.29 1.50	0.00 0.00 0.00 1.50	Subarea
Subbas 	sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas 	Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in):	Subarea A 0.04 170.00 0.29 1.50	0.00 0.00 0.00 1.50	Subarea
Subbas 	sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas 	Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 170.00 0.29 1.50 0.17	0.00 0.00 0.00 1.50 0.00	Subarea
Subbas	Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 170.00 0.29 1.50 0.17 16.45	0.00 0.00 0.00 1.50 0.00	
Subbas Sheet 	sin 0-4 Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes): el Flow Computations	Subarea A	0.00 0.00 0.00 1.50 0.00 0.00	
Subbas	Flow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes): el Flow Computations Manning's Roughness:	Subarea A	0.00 0.00 0.00 1.50 0.00 0.00	

0.00 Wetted Perimeter (ft): 0.38 3060.00 0.00 Velocity (ft/sec): 10.68 29.81 0.00 Computed Flow Time (minutes): 2.51 0.49	=======	Total TOC (minutes):	9.73		========
0.00 Wetted Perimeter (ft): 0.00 Velocity (ft/sec): 1.58 732.00 10.68 29.81	0.00	00mpa00a 210m 11m0 (m1ma00),	2.01	0.13	
0.00 Wetted Perimeter (ft): 1.58 732.00 0.00 Velocity (ft/sec): 10.68 29.81	0.00	Computed Flow Time (minutes):	2.51	0.49	
0.00 Wetted Perimeter (ft): 1.58 732.00		Velocity (ft/sec):	10.68	29.81	
		Wetted Perimeter (ft):	1.58	732.00	
0.00		Cross Section Area (ft²):	0.38	3660.00	

Node	Average	Maximum	Maximum		of Max	Total	Total	Retention
ID	Depth Attained	Depth Attained	HGL Attained	Occi	irrence	Flooded Volume	Time Flooded	Time
	ft	ft	ft	days	hh:mm	acre-in	minutes	hh:mm:ss
CAR-24	0.34	2.00	228.50	0	08:00	0	0	0:00:00
CAR-36	0.34	2.00	186.00	0	08:00	0	0	0:00:00
CAR-42	0.31	1.75	124.75	0	08:01	0	0	0:00:00
Jun-A	0.16	0.68	170.68	0	08:00	0	0	0:00:00
Jun-B	0.16	0.68	80.68	0	08:02	0	0	0:00:00
Jun-C	0.29	1.59	61.59	0	08:01	0	0	0:00:00
Jun-CAR10	0.16	0.83	21.83	0	08:00	0	0	0:00:00
Jun-D	0.31	1.31	36.31	0	08:02	0	0	0:00:00
Jun-E	0.63	2.68	22.68	0	08:04	0	0	0:00:00
RioRoadCulvert	0.64	2.68	22.58	0	08:06	0	0	0:00:00

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Peak	lime of Inflow arrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days hh:mm
CAR-24 CAR-36 CAR-42 Jun-A Jun-B Jun-C	JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION	87.02 0.00 0.00 42.09 13.03 1.03	87.02 86.90 86.81 42.09 54.39 142.13	0 0 0 0 0	08:00 08:00 08:01 08:00 08:01	0.00 0.00 0.00 0.00 0.00	
Jun-CAR10 Jun-D Jun-E RioRoadCulvert	JUNCTION JUNCTION JUNCTION OUTFALL	6.18 34.15 6.89 0.00	6.18 174.08 186.31 186.02	0 0 0 0	08:00 08:02 08:04 08:06	0.00 0.00 0.00 0.00	

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	48.50	35.43	186.02
System	48.50	35.43	186.02

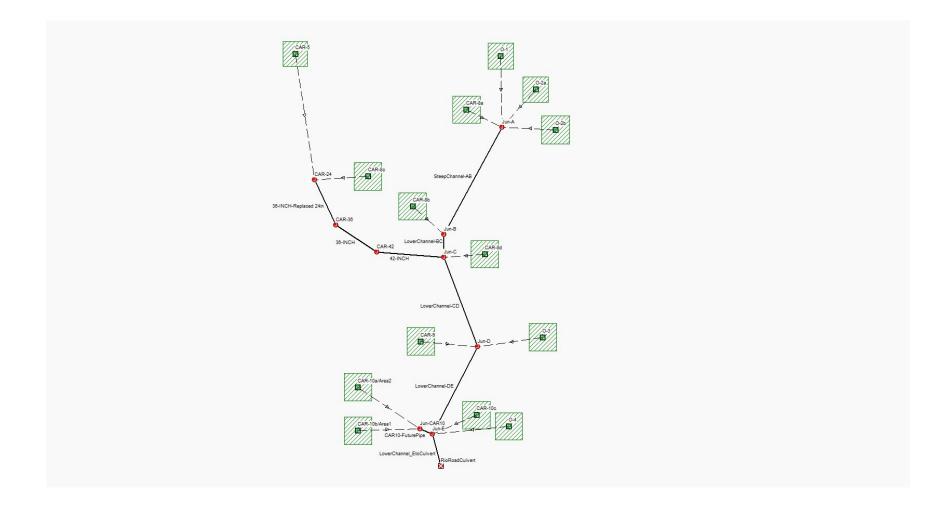
			T	ime of	Maximum	Length	Peak Flow	Design	Ratio of
Ratio of	Total	Reported	Pop!	r Flora	Vologity	Factor	during	Flor	Maximum
Maximum	Time		rea	C FIOW	verocity	ractor	dulling	FIOW	Maximum
			0ccu:	rrence	Attained		Analysis	Capacity	/Design
Flow Surchar	rged		,		5. /		-	-	-1
Depth mir	011+00		days	nn:mm	it/sec		cfs	CIS	Flow
Deben min	iuces								
		CONDUIT	0	08:01	20.40	1.00	86.81	135.69	0.64
0.58	0 Ca	lculated							
-	•		0	08:00	17.47	1.00	86.90	111.17	0.78
0.66									
42-INCH 0.46	0 0	CONDUIT	0	08:01	20.38	1.00	86.75	203.82	0.43
U.46	U Ca	Iculated	0	00 00	7 14	1 00	C 10	7 00	0.70
CAR10-Futur		lculated	U	08:00	7.14	1.00	6.18	7.92	0.78
		lvert CHANNEI		0 08.	06 1	43 1 0	0 186.02	6214 4	13
		0 Calcu		0 00.		13 1.0	0 100.02	0211.	.5
LowerChanne				08:02	7.60	1.00	54.38	87885.25	0.00
0.06	0 Ca	lculated							
LowerChanne	el-CD	CHANNEL	0	08:03	6.50	1.00	141.83	51403.88	0.00
0.11									
LowerChanne			0	08:04	5.63	1.00	173.86	39609.35	0.00
0.13	0 Ca	lculated							

SteepChannel-AB CHANNEL 0 08:02 5.02 1.00 41.65 54464.74 0.00 0.07 0 Calculated

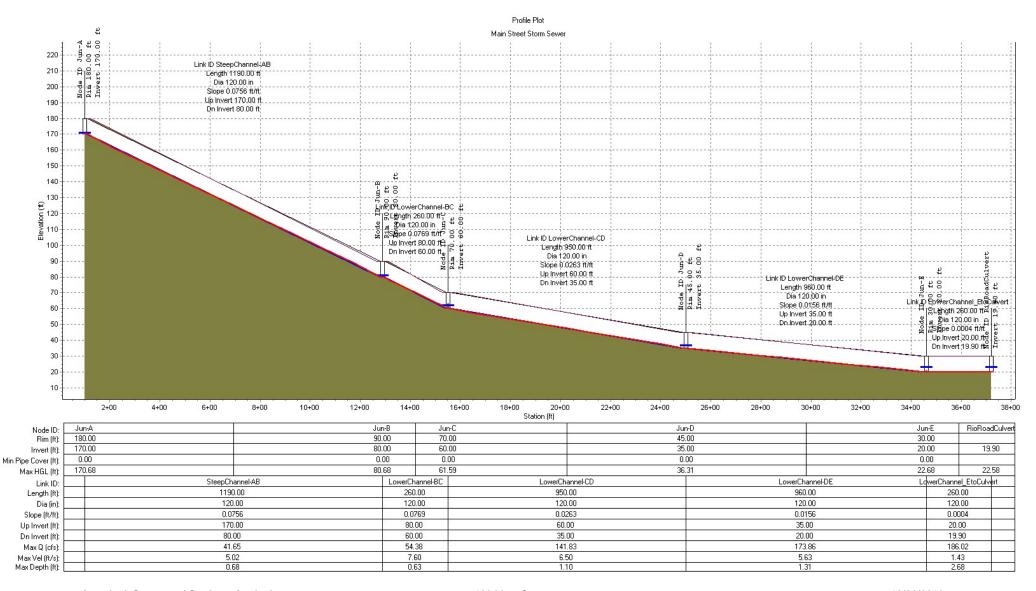
******** Highest Flow Instability Indexes All links are stable.

Analysis began on: Wed Dec 26 08:55:31 2018 Analysis ended on: Wed Dec 26 08:55:33 2018 Total elapsed time: 00:00:02

18-028 Mission Trail Creek Assessment Waterways Consulting, Inc.



18-028 Mission Trail Creek Assessment Waterways Consulting, Inc.



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Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)
******
Project Description
Analysis Options
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date ..... OCT-15-2018 00:00:00
Ending Date ..... OCT-17-2018 00:00:00
Report Time Step ..... 00:00:10
*****
Element Count
Number of rain gages ..... 1
Number of subbasins ..... 14
Number of nodes ..... 10
Number of links ..... 9
*****
Raingage Summary
Gage Data Data Recording ID Source Type Interval
_____
PebbleBeach 100-year CUMULATIVE 6.00
*****
Subbasin Summary
*****
CAR-10a/Area2 220905.11 0.00 PebbleBeach CAR-10b/Area1 936706.23 0.00 PebbleBeach CAR-10c 549564.77 0.00 PebbleBeach CAR-5 3421768.38 0.00 PebbleBeach CAR-8a 466351.13 0.00 PebbleBeach CAR-8b 1228692.05 0.00 PebbleBeach CAR-8b 3513067.02 0.00 PebbleBeach CAR-8c 3513067.02 0.00 PebbleBeach CAR-8d 84784.75 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach CAR-9 834219.64 0.00 PebbleBeach O-1 2106420.50 0.00 PebbleBeach O-2a 749809.98 0.00 PebbleBeach O-2b 911776.34 0.00 PebbleBeach O-3 3162314.26 0.00 PebbleBeach O-4 340813.63 0.00 PebbleBeach
_____
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Node Summary

Node ID	Element Type		Maximum Elev.	Ponded Area	External Inflow	
		ft		ft²		
CAR-24 CAR-36 CAR-42	JUNCTION JUNCTION JUNCTION	226.50 184.00 123.00		4.00 4.00 4.00		
Jun-A Jun-B Jun-C Jun-CAR10	JUNCTION JUNCTION JUNCTION JUNCTION	170.00 80.00 60.00 21.00	180.00 90.00 70.00 25.00	0.00 0.00 0.00 0.00		
Jun-D Jun-E RioRoadCulvert	JUNCTION JUNCTION	35.00 20.00	45.00	0.00		

Link Summary						
Link ID	From Node	To Node	Element Type		h Slope t %	
36-INCH 36-INCH-Replaced	CAR-36 24inCAR-24	CAR-42 CAR-36	CONDUIT CONDUI	1107.	0 5.5104 1149.0 3.	0.0150
0.0150 42-INCH CAR10-FuturePipe LowerChannel_Eto	CAR-42 Jun-CAR10 CulvertJun-E	Jun-C Jun-E RioRoadO	CONDUIT CONDUIT Culvert CHAN	50.	0 2.0000	0.0150
0.0250 LowerChannel-BC	Jun-B	Jun-C	CHANNEL	260.	0 7.6923 0 2.6316	0.0250
LowerChannel-CD LowerChannel-DE SteepChannel-AB	Jun-D	Jun-E	CHANNEL CHANNEL CHANNEL	960.	0 2.6316 0 1.5625 0 7.5630	0.0250 0.0250 0.0400

Cross Section Sur						
Link Design	Shape	Depth/	Width	No. of	Cross	Full Flow
ID Flow		Diameter		Barrels	Sectional	Hydraulic
					Area	Radius
Capacity		ft	ft		ft²	ft
cfs						
36-INCH 135.69	CIRCULAR	3.00	3.00	1	7.07	0.75
36-INCH-Replaced 0.75 111.17	24in CIRCULAR	3.00	3.00		1	7.07
42-INCH 203.82	CIRCULAR	3.50	3.50	1	9.62	0.88
CAR10-FuturePipe	CIRCULAR	1.25	1.25	1	1.23	0.31
LowerChannel_Eto	Culvert TRIANGU	LAR 10.00	365.0	00	1 1	825.00
LowerChannel-BC 87885.25	TRIANGULAR	10.00	365.00	1	1825.00	4.99
LowerChannel-CD 51403.88	TRIANGULAR	10.00	365.00	1	1825.00	4.99
LowerChannel-DE 39609.35	TRIANGULAR	10.00	365.00	1	1825.00	4.99
SteepChannel-AB	TRIANGULAR	10.00	365.00	1	1825.00	4.99

54464.74

******** Runoff Quantity Continuity *******	Volume acre-ft	Depth inches			
Total Precipitation Surface Runoff Continuity Error (%)	129.370 74.252 0.000	3.650 2.095			
**************************************	Volume acre-ft	Volume Mgallons			
External Inflow External Outflow Initial Stored Volume Final Stored Volume Continuity Error (%)	0.000 74.218 0.000 0.000 0.000	0.000 24.185 0.000 0.000			
******	*****				
Composite Curve Number Comput	ations Report				
Subbasin CAR-10a/Area2					
		_		0 11	
Soil/Surface Description		(Soil Group	CN
Composite Area & Weighted CN		22090			81.00
Subbasin CAR-10b/Area1					
Soil/Surface Description			rea ft²)	Soil Group	CN
Composite Area & Weighted CN		93670	6.23		73.00
Subbasin CAR-10c					
Soil/Surface Description		(rea ft²)	Soil Group	CN
Composite Area & Weighted CN		54956	4.77		74.00
Subbasin CAR-5					
Soil/Surface Description		(rea ft²)	Soil Group	CN
Composite Area & Weighted CN		342176	8.38		91.00
Subbasin CAR-8a					
Soil/Surface Description		(rea ft²)	Soil Group	CN
Composite Area & Weighted CN					
composite Area & weighted CN		40033	1.10		21.00
Subbasin CAR-8b					

	Area	Soil	
Soil/Surface Description	(ft ²)	Group	CN
Composite Area & Weighted CN	1228692.05		85.00
Subbasin CAR-8c			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3513067.02		85.00
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00
Subbasin 0-1			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	2106420.50		83.00
Subbasin 0-2a			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00
Subbasin 0-2b			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00
Subbasin 0-3			
Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3162314.26		83.00
Subbasin 0-4			
Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63		87.00

Subbasin CAR-10a/Area2			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	220905.11 220905.11		0.72 0.72
Subbasin CAR-10b/Area1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	936706.23 936706.23	-	0.72 0.72
Subbasin CAR-10c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	549564.77 549564.77		0.72 0.72
Subbasin CAR-5			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	4718448.95 4718448.95	-	0.72 0.72
Subbasin CAR-8a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	466351.13 466351.13	-	0.72 0.72
Subbasin CAR-8b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	1228692.05 1228692.05	-	0.72 0.72
Subbasin CAR-8c			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

- Composite Area & Weighted Runoff Coeff.	3513067.02 3513067.02	-	0.72 0.72
Subbasin CAR-8d			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	84784.75 84784.75	-	0.72 0.72
Subbasin CAR-9			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	834219.64 834219.64	-	0.72 0.72
Subbasin O-1			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	2106420.50 2106420.50	-	0.72 0.72
Subbasin O-2a			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
Composite Area & Weighted Runoff Coeff.	749809.98 749809.98	-	0.72 0.72
Subbasin O-2b			
Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	911776.34 911776.34	-	0.72 0.72
Subbasin O-3			
Soil/Surface Description		Soil Group	Runoff Coeff.
- Composite Area & Weighted Runoff Coeff.	3162314.26 3162314.26	-	0.72 0.72
Subbasin O-4			
Soil/Surface Description		Soil Group	Runoff Coeff.

```
SCS TR-55 Time of Concentration Computations Report
  Sheet Flow Equation
           Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))
           Where:
           Tc = Time of Concentration (hrs)
           n = Manning's Roughness
           Lf = Flow Length (ft)
           P = 2 yr, 24 hr Rainfall (inches)
           Sf = Slope (ft/ft)
  Shallow Concentrated Flow Equation
           V = 16.1345 * (Sf^0.5) (unpaved surface)
           V = 20.3282 * (Sf^0.5) (paved surface)
           V = 15.0 * (Sf^0.5) (grassed waterway surface)
           V = 10.0 * (Sf^0.5)  (grassed waterway surface)

V = 10.0 * (Sf^0.5)  (nearly bare & untilled surface)

V = 9.0 * (Sf^0.5)  (cultivated straight rows surface)
           V = 7.0 * (Sf^0.5) (short grass pasture surface)
           V = 5.0 * (Sf^0.5) (woodland surface)

V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
           Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           V = Velocity (ft/sec)
Sf = Slope (ft/ft)
  Channel Flow Equation
           V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n
           R = Aq / Wp

Tc = (Lf / V) / (3600 sec/hr)
           Where:
           Tc = Time of Concentration (hrs)
           Lf = Flow Length (ft)
           R = Hydraulic Radius (ft)
           Aq = \overline{Flow} Area (ft^2)
           Wp = Wetted Perimeter (ft)
           V = Velocity (ft/sec)
           Sf = Slope (ft/ft)
           n = Manning's Roughness
  Subbasin CAR-10a/Area2
  Sheet Flow Computations
                                                        Subarea A
                                                                             Subarea B
                                                                                                     Subarea
                                                             0.04
                                                                                     0.00
         Manning's Roughness:
                                                             65.00
                                                                                     0.00
          Flow Length (ft):
0.00
```

С

0.00	Slope (%):	0.77	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.21	0.00	
0.00	Computed Flow Time (minutes):	5.16	0.00	
	L Flow Computations			
2		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	1180.00	884.00	
0.00	Channel Slope (%):	8.05	7.49	
0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	12.47	29.81	
0.00	Computed Flow Time (minutes):	1.58	0.49	
=======	Total TOC (minutes):	3.62		

Subbasin CAR-10b/Area1

Sheet Flow Computations

C		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	111.00	0.00	
0.00	3	1.80	0.00	
0.00	Slope (%):	1.00	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.33	0.00	
0.00	Computed Flow Time (minutes):	5.64	0.00	
0.00				
Channel	Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2186.00	0.00	
0.00	3			
0.00	Channel Slope (%):	5.43	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	

	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	10.24	0.00	
0.00	Computed Flow Time (minutes):	3.56	0.00	
0.00	-			
	Total TOC (minutes):	9.19		=======
======				
Subba	sin CAR-10c			
	Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	106.00	0.00	
0.00	Slope (%):	0.94	0.00	
0.00	2 yr, 24 hr Rainfall (in):	1.50	1.50	
1.50	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	7.04	0.00	
Channe	el Flow Computations			
		Subarea A	Subarea B	Subarea
C 0.00	Manning's Roughness:	0.01	0.04	
0.00	Flow Length (ft):	954.00	884.00	
0.00	Channel Slope (%):	8.91	7.49	
0.00	Cross Section Area (ft²):	0.75	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	Velocity (ft/sec):	20.82	29.81	
0.00	Computed Flow Time (minutes):	0.76	0.49	
	Total TOC (minutes):	4.15		=======
	sin CAR-5			
				
Sheet	Flow Computations			
С		Subarea A	Subarea B	Subarea

00	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	108.00	0.00	
	Slope (%):	0.93	0.00	
00 50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.25	0.00	
	Computed Flow Time (minutes):	7.18	0.00	
	Elev Computations			
	Flow Computations	Coole a coole a 7	Cula man D	Carlonana
	Manajarta Daurhaan	Subarea A		Subarea
00	Manning's Roughness:	0.01	0.01	
00	Flow Length (ft):	2487.00	2541.00	
00	Channel Slope (%):	6.90	6.49	
00	Cross Section Area (ft²):	0.38	3.14	
00	Wetted Perimeter (ft):	1.58	6.28	
00	Velocity (ft/sec):	11.54	18.39	
	Computed Flow Time (minutes):	3.59	2.30	
00				
		6.54		
====== ===============================	Total TOC (minutes): CAR-8a	6.54		
Subbasin	Total TOC (minutes): CAR-8a ow Computations	6.54		
Subbasin	Total TOC (minutes):	6.54		
Subbasin	Total TOC (minutes): CAR-8a ow Computations	6.54		
Subbasin	Total TOC (minutes): CAR-8a ow Computations	6.54 Subarea A	Subarea B	
SubbasinSheet Fl	Total TOC (minutes): CAR-8a ow Computations Manning's Roughness:	6.54 Subarea A 0.04	Subarea B 0.00	
Subbasin Sheet Fl	Total TOC (minutes): CAR-8a ow Computations Manning's Roughness: Flow Length (ft):	6.54 Subarea A 0.04 108.00	Subarea B 0.00 0.00	
SubbasinSubbasin	Total TOC (minutes): CAR-8a ow Computations Manning's Roughness: Flow Length (ft): Slope (%):	6.54 Subarea A 0.04 108.00 1.85	Subarea B 0.00 0.00 0.00	
Subbasin Sheet Fl 000 00 00 50	Total TOC (minutes): CAR-8a ow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in):	Subarea A 0.04 108.00 1.85 1.50	Subarea B 0.00 0.00 0.00 1.50	
Subbasin Sheet Fl 00 00 00 00 00 00 00 00 00	Total TOC (minutes): CAR-8a Ow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33	Subarea B 0.00 0.00 0.00 1.50 0.00	
Subbasin Sheet Fl 00 00 00 00 00 00 00 00 00	Total TOC (minutes): CAR-8a Ow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	Subarea
Subbasin Sheet Fl 00 00 00 00 00 00 00 00 00	Total TOC (minutes): CAR-8a Ow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33	Subarea B	Subarea
Subbasin Sheet Fl 00 00 00 00 Channel	Total TOC (minutes): CAR-8a Ow Computations Manning's Roughness: Flow Length (ft): Slope (%): 2 yr, 24 hr Rainfall (in): Velocity (ft/sec): Computed Flow Time (minutes):	Subarea A 0.04 108.00 1.85 1.50 0.33 5.45	Subarea B 0.00 0.00 0.00 1.50 0.00 0.00	

	Channel Slope (%):	1.37	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	5.14	0.00	
	Computed Flow Time (minutes):	4.10	0.00	
_	Total TOC (minutes):	9.55		
 as	sin CAR-8b			
_	Flow Computations			
-		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	102.00	0.00	
	Slope (%):	0.98	0.00	
	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.25	0.00	
	Computed Flow Time (minutes):	6.72	0.00	
. ∈	el Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
	Flow Length (ft):	1419.00	0.00	
	Channel Slope (%):	10.29	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	14.09	0.00	
	Computed Flow Time (minutes):	1.68	0.00	
==	Total TOC (minutes):	8.40		========

Subbasin CAR-8c

	Flow Computations			
		Subarea A	Subarea B	Subarea
C 0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	102.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.25	0.00	
0.00	Computed Flow Time (minutes):	6.72	0.00	
	l Flow Computations			
		Subarea A	Subarea B	Subarea
C	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	1136.00	0.00	
0.00	Channel Slope (%):	10.12	0.00	
0.00	Cross Section Area (ft²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	13.98	0.00	
0.00	Computed Flow Time (minutes):	1.35	0.00	
	Total TOC (minutes):	8.07		
Subbas Sheet	in CAR-8d Flow Computations			
С		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	300.00	0.00	
0.00	Slope (%):	0.98	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.31	0.00	
0.00	Computed Flow Time (minutes):	15.92	0.00	
	l Flow Computations			
C		Subarea A	Subarea B	Subarea

	Manning's Roughness:	0.08	0.00	
	Flow Length (ft):	416.00	0.00	
	Channel Slope (%):	21.36	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
	Velocity (ft/sec):	3.30	0.00	
	Computed Flow Time (minutes):	2.10	0.00	
	Total TOC (minutes):	18.03		
sir	CAR-9			
et Fl	ow Computations	Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	300.00	0.00	
	Slope (%):	1.00	0.00	
	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.32	0.00	
	Computed Flow Time (minutes):	15.80	0.00	
	, , , , , , , , , , , , , , , , , , , ,			
	Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.00	
	Flow Length (ft):	463.00	0.00	
	Channel Slope (%):	16.20	0.00	
	Cross Section Area (ft²):	0.38	0.00	
	Wetted Perimeter (ft):	1.58	0.00	
		17.68	0.00	
	Velocity (ft/sec):	17.00		
	<pre>Velocity (ft/sec): Computed Flow Time (minutes):</pre>	0.44	0.00	

Subbasir	 n 0-1			
	low Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.04	0.00	
.00	Flow Length (ft):	80.00	0.00	
00	Slope (%):	1.33	0.00	
50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
	Velocity (ft/sec):	0.27	0.00	
0	Computed Flow Time (minutes):	4.90	0.00	
Channel	Flow Computations			
		Subarea A	Subarea B	Subarea
	Manning's Roughness:	0.01	0.04	
)	Flow Length (ft):	5294.00	1069.00	
	Channel Slope (%):	1.60	7.48	
	Cross Section Area (ft²):	0.38	3660.00	
l I	Wetted Perimeter (ft):	1.58	732.00	
	Velocity (ft/sec):	5.56	29.79	
	Computed Flow Time (minutes):	15.88	0.60	
	Total TOC (minutes):	10.68		
 ıbbasir				
	User-Defined TOC override (minutes):	5.00		
ıbbasir	 n 0-2b 			
heet Fl	low Computations			
		Subarea A	Subarea B	Subarea
ı	Manning's Roughness:	0.04	0.00	
	Flow Length (ft):	123.00	0.00	
	Slope (%):	1.63	0.00	

1.50				
0.00	Velocity (ft/sec):	0.32	0.00	
	Computed Flow Time (minutes):	6.37	0.00	
0.00 Chann	el Flow Computations			
		Subarea A	Subarea B	Subarea
С	Manning's Roughness:	0.01	0.00	
0.00	Flow Length (ft):	2136.00	0.00	
0.00	Channel Slope (%):	8.43	0.00	
0.00	Cross Section Area (ft ²):	0.38	0.00	
0.00	Wetted Perimeter (ft):	1.58	0.00	
0.00	Velocity (ft/sec):	12.76	0.00	
0.00	Computed Flow Time (minutes):	2.79	0.00	
0.00	(
======	Total TOC (minutes):	9.16		========
Subba	User-Defined TOC override (minutes): 5.00		
	Flow Computations			
С		Subarea A	Subarea B	Subarea
0.00	Manning's Roughness:	0.04	0.00	
0.00	Flow Length (ft):	170.00	0.00	
0.00	Slope (%):	0.29	0.00	
1.50	2 yr, 24 hr Rainfall (in):	1.50	1.50	
0.00	Velocity (ft/sec):	0.17	0.00	
0.00	Computed Flow Time (minutes):	16.45	0.00	
Chann	el Flow Computations			
С		Subarea A	Subarea B	Subarea
0 0 0	Manning's Roughness:	Subarea A	Subarea B 0.04	Subarea
0.00	Manning's Roughness: Flow Length (ft):			Subarea
0.00		0.01	0.04	Subarea

0.00	Cross Section Area (ft²):	0.38	3660.00	
0.00	Wetted Perimeter (ft):	1.58	732.00	
0.00	<pre>Velocity (ft/sec):</pre>	10.68	29.81	
0.00	Computed Flow Time (minutes):	2.51	0.49	
=======	Total TOC (minutes):	9.73		=======

Node ID	Average Depth Attained	Maximum Depth Attained	Maximum HGL Attained		of Max irrence	Total Flooded Volume	Total Time Flooded	Retention Time
	ft	ft	ft	days	hh:mm	acre-in	minutes	hh:mm:ss
CAR-24	0.35	2.13	228.63	0	08:00	0	0	0:00:00
CAR-36	0.35	2.12	186.12	0	08:00	0	0	0:00:00
CAR-42	0.32	1.84	124.84	0	08:01	0	0	0:00:00
Jun-A	0.17	0.71	170.71	0	08:00	0	0	0:00:00
Jun-B	0.17	0.70	80.70	0	08:02	0	0	0:00:00
Jun-C	0.31	1.67	61.67	0	08:01	0	0	0:00:00
Jun-CAR10	0.16	0.93	21.93	0	08:00	0	0	0:00:00
Jun-D	0.32	1.35	36.35	0	08:02	0	0	0:00:00
Jun-E	0.66	2.78	22.78	0	08:04	0	0	0:00:00
RioRoadCulvert	0.66	2.78	22.68	0	08:06	0	0	0:00:00

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Peak	lime of Inflow arrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days hh:mm
CAR-24 CAR-36 CAR-42 Jun-A Jun-B Jun-C Jun-CAR10 Jun-D Jun-E	JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION JUNCTION	94.58 0.00 0.00 46.36 14.31 1.11 7.11 37.97	94.58 94.44 94.36 46.36 59.91 155.30 7.11 190.87 204.81	0 0 0 0 0 0	08:00 08:00 08:01 08:01 08:01 08:01 08:00 08:02	0.00 0.00 0.00 0.00 0.00 0.00 0.00	
RioRoadCulvert	OUTFALL	0.00	204.50	0	08:06	0.00	

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	48.75	38.37	204.50
System	48.75	38.37	204.50

Link ID	Element	Ti	me of	Maximum	Length	Peak Flow	Design	Ratio of
Ratio of	Total Reported							
	Type	Peak	Flow	Velocity	Factor	during	Flow	Maximum
Maximum	Time Condition							
		Occur	rence	Attained		Analysis	Capacity	/Design
Flow Surchard	ged							
		days	hh:mm	ft/sec		cfs	cfs	Flow
Depth minu	ıtes							
26 777077		0	00 01	00 70	1 00	0.4.06	125 60	0.70
	CONDUIT	0	08:01	20.78	1.00	94.36	135.69	0.70
	0 Calculated	0	00 00	17 70	1 00	04.44	111 10	0.05
	Laced 24in CONDUIT	0	08:00	17.72	1.00	94.44	111.17	0.85
	0 Calculated	0	08:01	20.82	1.00	94.30	203.82	0.46
42-INCH	CONDUIT 0 Calculated	U	08:01	20.82	1.00	94.30	203.82	0.46
		0	08:00	7.30	1.00	7.11	7.92	0.90
	ePipe CONDUIT 0 Calculated	U	00:00	7.30	1.00	/ • 11	1.92	0.90
	L EtoCulvert CHANNE	'T	n ng.(16 1	46 1 O	0 204.50	6214	13
	B 0 Calc		0 00.0	,,	10 1.0	204.50	0214.	10
	L-BC CHANNEL		08:02	7 78	1.00	59.90	87885.25	0.00
	0 Calculated	O	00.02	7.70	1.00	33.30	07003.23	0.00
	L-CD CHANNEL	Ο	08:03	6.64	1.00	154.93	51403.88	0.00
	0 Calculated	0		0.01	1.00	101.00	01100.00	0.00
	L-DE CHANNEL	0	08:04	5.76	1.00	190.70	39609.35	0.00
	0 Calculated	O		3.70	1.00	130.70	0,00,00	3.00

SteepChannel-AB CHANNEL 0 08:02 5.14 1.00 45.91 54464.74 0.00 0.07 0 Calculated

******** Highest Flow Instability Indexes All links are stable.

Analysis began on: Wed Dec 26 08:46:34 2018 Analysis ended on: Wed Dec 26 08:46:35 2018 Total elapsed time: 00:00:01

Appendix 2: Hydraulic Modeling Results at Select Cross Sections

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

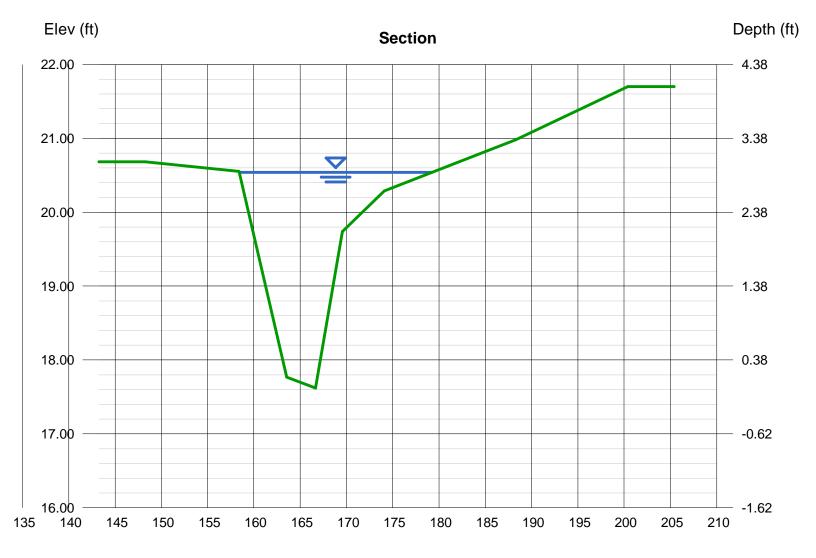
Thursday, Dec 27 2018

CROSS SECTION-A

User-defined		Highlighted	
Invert Elev (ft)	= 17.62	Depth (ft)	= 2.92
Slope (%)	= 0.90	Q (cfs)	= 122.00
N-Value	= 0.030	Area (sqft)	= 24.41
		Velocity (ft/s)	= 5.00
Calculations		Wetted Perim (ft)	= 22.25
Compute by:	Known Q	Crit Depth, Yc (ft)	= 2.60
Known Q (cfs)	= 122.00	Top Width (ft)	= 20.82
		EGL (ft)	= 3.31

(Sta, El, n)-(Sta, El, n)...

(148.26, 20.68) - (158.39, 20.55, 0.030) - (163.53, 17.77, 0.030) - (166.65, 17.62, 0.030) - (169.57, 19.74, 0.030) - (174.08, 20.29, 0.030) - (188.29, 20.98, 0.030) - (200.40, 21.70, 0.030)



C+0 /f+1

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

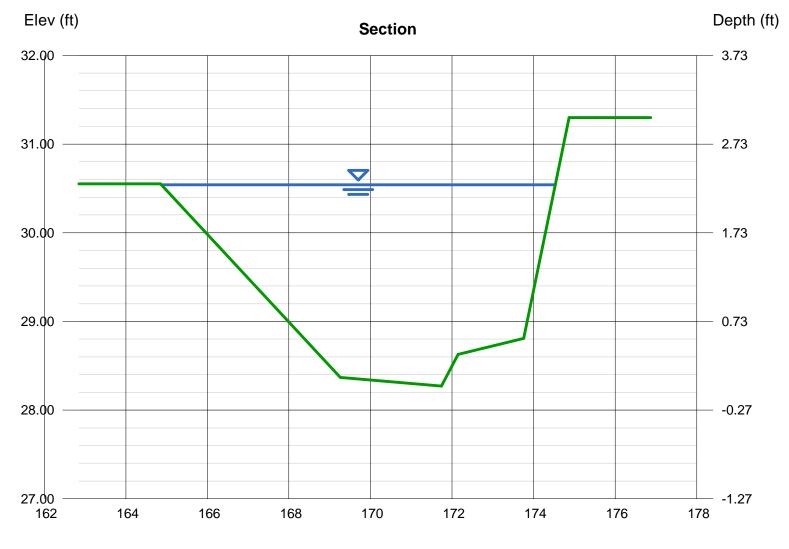
Thursday, Dec 27 2018

CROSS SECTION-D

User-defined		Highlighted	
Invert Elev (ft)	= 28.27	Depth (ft)	= 2.27
Slope (%)	= 0.90	Q (cfs)	= 82.00
N-Value	= 0.030	Area (sqft)	= 14.72
		Velocity (ft/s)	= 5.57
Calculations		Wetted Perim (ft)	= 11.44
Compute by:	Known Q	Crit Depth, Yc (ft)	= 2.02
Known Q (cfs)	= 82.00	Top Width (ft)	= 9.66
		EGL (ft)	= 2.75

(Sta, El, n)-(Sta, El, n)...

(164.85, 30.55)-(169.26, 28.37, 0.030) -(171.74, 28.27, 0.030) -(172.15, 28.63, 0.030) -(173.76, 28.81, 0.030) -(174.87, 31.30, 0.030)



C+0 /f+1

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

= 37.21

Thursday, Dec 27 2018

CROSS SECTION-G

User-defined	
Invert Flev (ft)	

Slope (%) = 1.30 N-Value = 0.030

Calculations

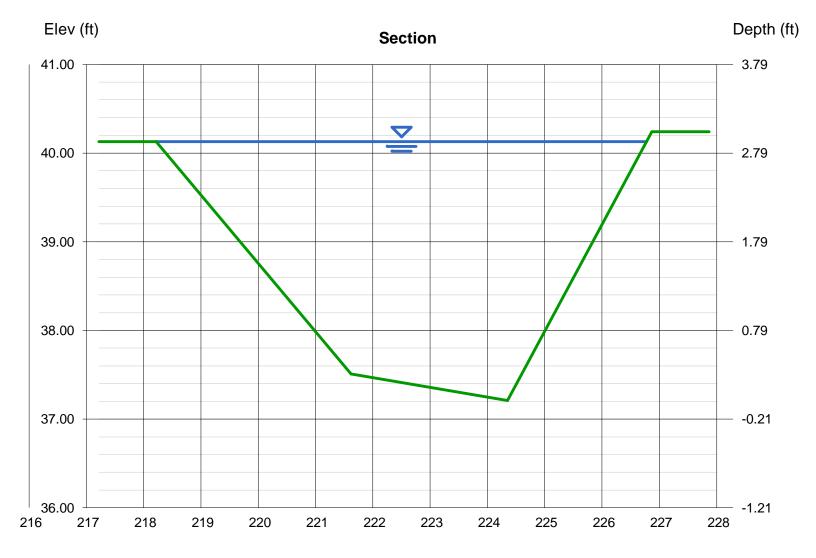
Compute by: Known Q Known Q (cfs) = 112.00

(Sta, El, n)-(Sta, El, n)...

(218.22, 40.13) -(221.62, 37.51, 0.030) -(224.35, 37.21, 0.030) -(226.87, 40.24, 0.030)

Highlighted

Depth (ft) = 2.92Q (cfs) = 112.00Area (sqft) = 15.56Velocity (ft/s) = 7.20Wetted Perim (ft) = 10.84Crit Depth, Yc (ft) = 2.84Top Width (ft) = 8.56EGL (ft) = 3.73



Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Dec 27 2018

CROSS SECTION-K

User-defined	
Invert Elev (ft)	= 59.45
Slope (%)	= 14.00
N-Value	= 0.100

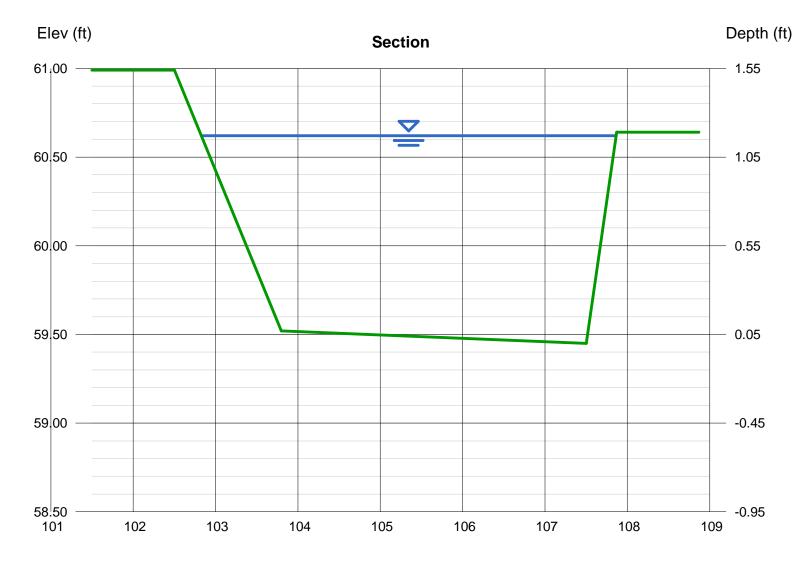
Calculations

Compute by: Known Q Known Q (cfs) = 23.00

(Sta, El, n)-(Sta, El, n)...

(102.50, 60.99) -(103.80, 59.52, 0.100) -(107.50, 59.45, 0.100) -(107.87, 60.64, 0.100)

Highlighted		
Depth (ft)	=	1.17
Q (cfs)	=	23.00
Area (sqft)	=	4.95
Velocity (ft/s)	=	4.65
Wetted Perim (ft)	=	6.39
Crit Depth, Yc (ft)	=	1.05
Top Width (ft)	=	5.04
EGL (ft)	=	1.51



Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

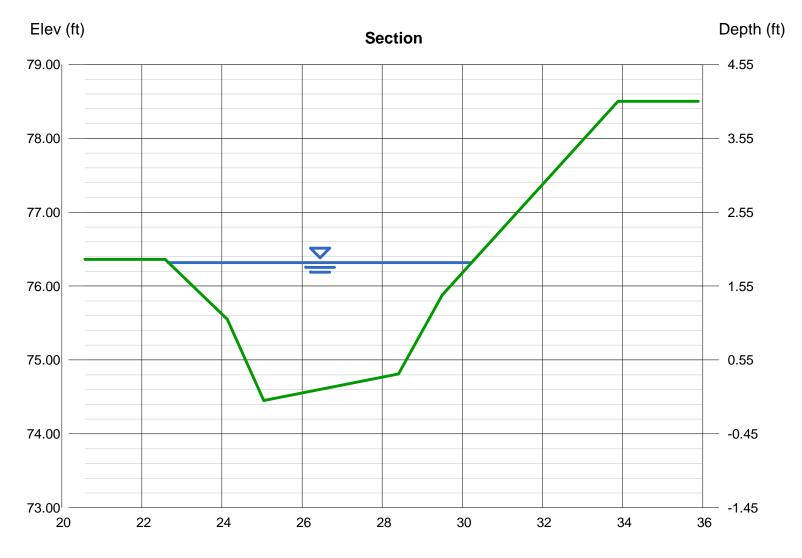
Thursday, Dec 27 2018

CROSS SECTION-M

User-defined		Highlighted	
Invert Elev (ft)	= 74.45	Depth (ft)	= 1.87
Slope (%)	= 7.20	Q (cfs)	= 20.00
N-Value	= 0.170	Area (sqft)	= 8.69
		Velocity (ft/s)	= 2.30
Calculations		Wetted Perim (ft)	= 8.87
Compute by:	Known Q	Crit Depth, Yc (ft)	= 1.13
Known Q (cfs)	= 20.00	Top Width (ft)	= 7.58
		EGL (ft)	= 1.95

(Sta, El, n)-(Sta, El, n)...

(22.58, 76.36) -(24.13, 75.55, 0.170) -(25.04, 74.45, 0.170) -(28.41, 74.81, 0.170) -(29.50, 75.88, 0.170) -(33.89, 78.50, 0.170)



C+0 /f+1



REVISED: AUGUST, 2009 REVISED: JUNE, 2011 REVISED: JANUARY, 2012 REVISED: AUGUST, 2014 SCALE: 1"= 400" JANUARY, 2007 MENSUNA ENSTEN - WELLSUS EN FUING EN CARMEL 3. OUTFALLS C-2, C-7, C-8, C-10 ARE RCP WITH A SHORT SECTION OF LARGER DIAMETER HDPE ADDED TO THE END OF THE RCP TO EXTEND THEIR POINTS-OF-DISCHARGE. 5. OUTFALLS C-8, C-17S, C-20 AND C-26 HAVE OPEN BOTTOM CATCH BASINS AT CURBFACE DRAIN INLETS FOR DRY WEATHER DIVERSION 2. OUTFALL C-23 IS A SUBSURFACE DISCHARGE IN THE HILLSIDE. . OUTFALL NUMBERS C-5, C-15, C-16, AND C-22 ARE NOT USED. OUTFALLS C-14 AND C-24 ARE EACH TWO PIPES DISCHARGING AT THE SAME POINT. CARO62 OUTFALLS C-2, C-3, C-6, C-7, C-10, C-13, C-14 AND C-18 HAVE VARIOUS PERCOLATION TRENCHES (IDENTIFIED AS PERC) FOR DRY WEATHER DIVERSION NOTES 2 LEGEND DISCHARGE NUMBER SWRCB ASBS LIST OUTFALL NUMBER CITY OF CARMELLS Y-THISSEA C-12 OPEN BOTTOM CATCH BASIN FOR DRY WEATHER DIVERSION C-14 OPEN BOTTOM MANHOLE AS PART OF THE DRY WEATHER DIVERSION SYSTEM 6" CURBFACE TO CURBFACE CROSS DRAIN WITH ALL WATER FLOWING TO C6 (25) (7) (8) CARMEL RIVER STATE PARK CARMEL BAY

