Attachment 7, Technical Justification of Project

Technical Justification

Project Physical Benefits

The proposed project will protect 220 acres against flooding during medium to large storm events. In addition the proposed project will capture, convey and recharge approximately 400 acre-feet per year of rainstorm runoff that would otherwise be lost to the Chino Basin. Once recycled water is made available to the proposed basin an additional 400 acre-feet of recycled water will be allowed to blend with the 400 acre-feet of rainstorm flows (50/50) blend decreasing the need of imported water by as much 800 acre-feet per year.

By reducing the amount of imported water a reduction in greenhouse gases by reducing energy required to transport imported water will add to the benefits.

It is estimated that approximately 690 metric tons of CO_2 per year will be eliminated based on the Natural Resources Defense Council, pumping 1 ac-ft of State Water Project water to southern California requires 3,000 kWh and pumping 1 ac-ft of Colorado River Aqueduct water to the region requires about 2,000 kWh. As a result, using both sources, on average, requires 2,500 kWh for 1 ac-ft volume. The EPA estimated an emission factor of 6.8956×10^{-4} metric tons of CO_2 per kWh. Therefore, for an estimated 400 ac-ft per year, the proposed project will eliminate 690 metric tons of CO_2 each year.

DRAFT

Technical Memorandum (TM) 14th Street Water Quality Regional Facility

For the

City of Upland

Prepared by

AECOM

1131 W. 6th St
Ontario, CA 91762

August 5th, 2010

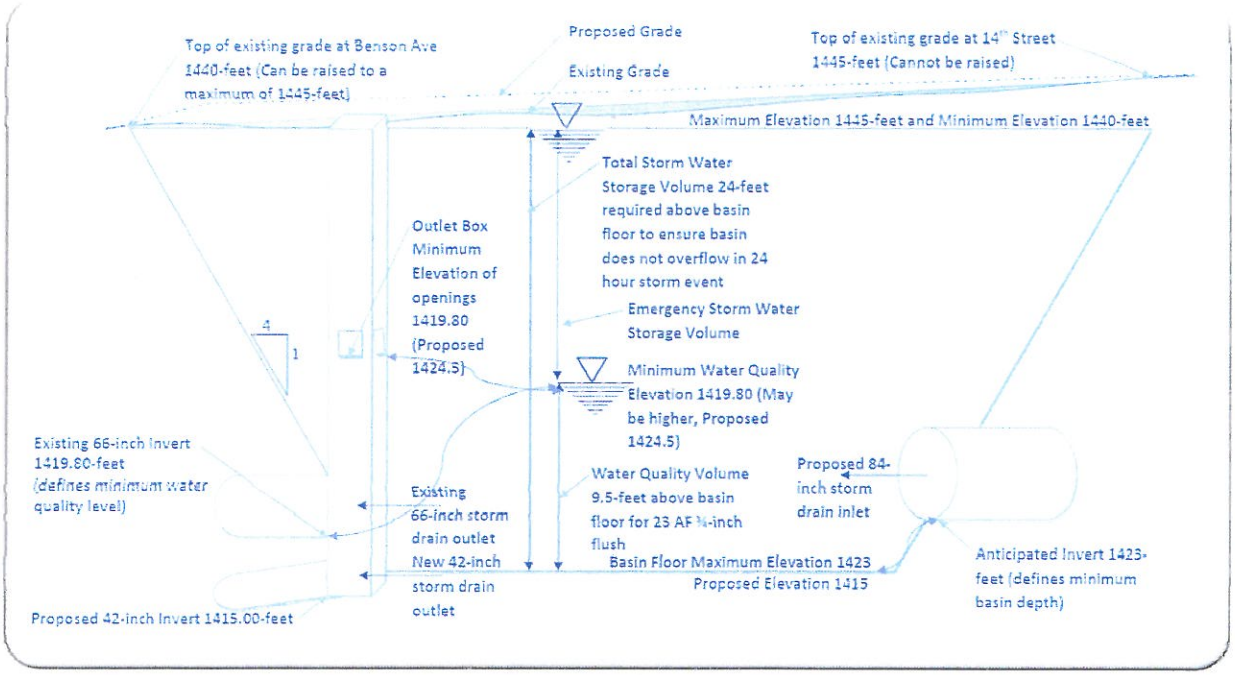

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Table of Contents

Introduction

This Technical Memorandum (TM) discusses the elements related to the design of the 14th Street Water Quality Regional Facility in the City of Upland, CA. The purpose of this project is to capture existing storm water flows from Mountain Ave and divert these flows east along 14th Street to a Water Quality infiltration basin. Capturing this storm water flow within the 14th Street Water Quality Regional Facility (basin) will serve both to improve downstream water quality by capturing and holding the first ¾- inch flush, and as a flood control basin by capturing and diverting a large volume of water. The first ¾-inch flush which contains many pollutants will remain within the basin and infiltrate into the groundwater below. The remainder of the storm water flow being captured for flood control will be diverted either to the Holiday Pit via the existing 66-inch pipeline, or to the Upland Basin within the City via a new 42-inch storm drain connecting to existing storm drains within Benson Avenue. The 14th Street Water Quality Regional Facility consists of the following items:

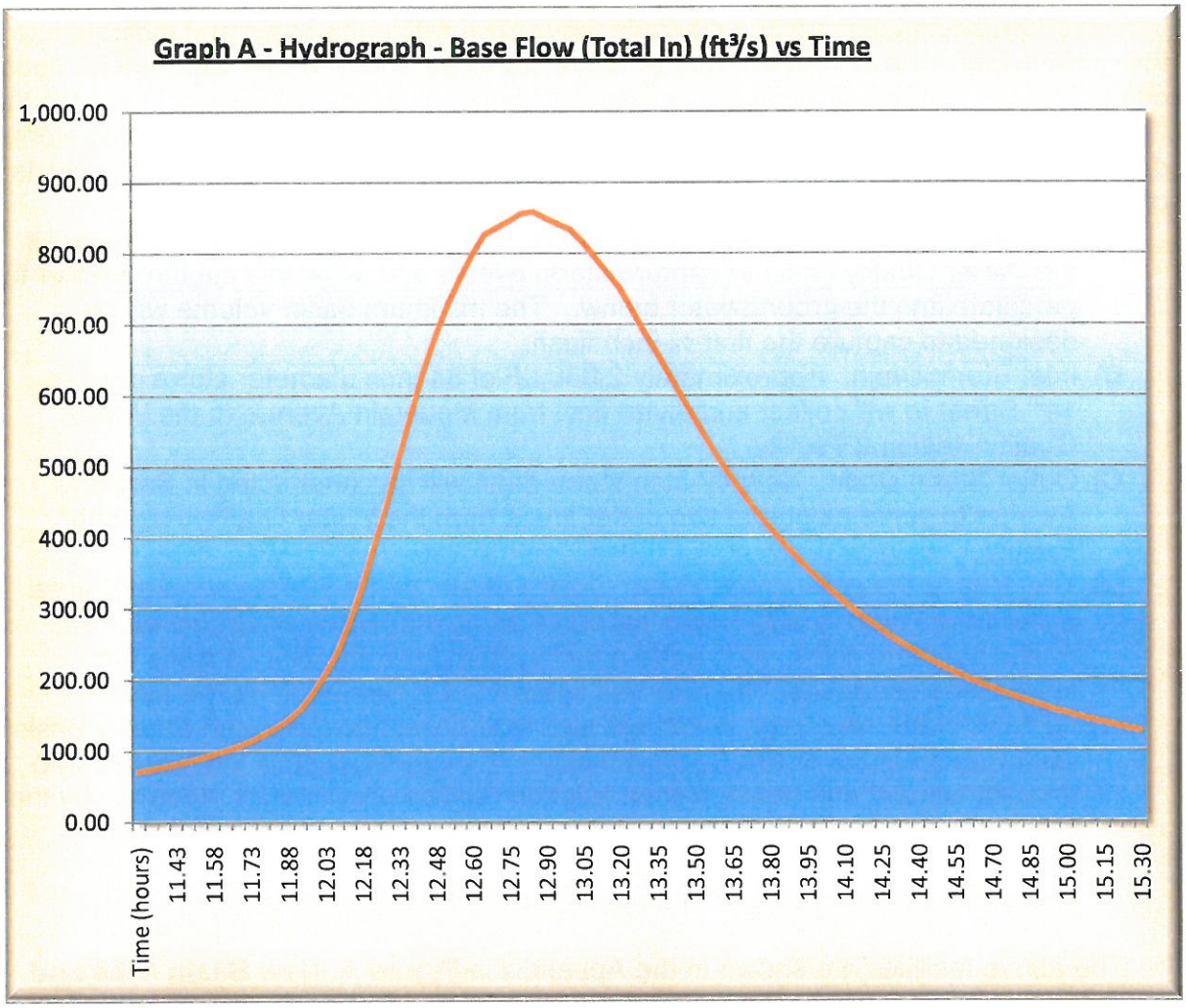
A) Desilting / Water Quality Basin. Approximately 6.22 acres of area will serve as the Water Quality basin to capture storm events and allow this captured water to percolate into the groundwater below. The minimum basin volume will be designed to capture the first ¾-inch flush.
B) Inlet Storm Drain. Approximately 2,000 LF of 84-inch diameter storm drain in 14th Street to will collect and divert flow from Mountain Avenue to the Water Quality Regional Facility.
C) Outlet Storm Drain. New 42-inch storm drain will be constructed in Benson Avenue to serve as one of two outlet areas from the Water Quality Regional Facility.
D) The area to the north of the Water Quality Basin, and a 50-foot perimeter area around the Water quality Basin will serve as an expansion of Greenbelt Park. Public park amenities will include a trail system for community access for recreational purposes. The new trail system will meander along the upper portions of the new basin which will also lead down into the Water Quality Basin itself with a natural environment emulating the existing foothill landscapes with drought tolerant and native plants. Irrigation will be provided for utilization by the City in the first few critical years until the landscaping is established. Trail surfaces would be of natural crushed rock or decomposed granite with occasional rock cropping to simulate dry stream beds and boulder-scapes.

The above facilities are shown in the Appendix in **Figure A, New Basin Area and Existing Utilities within the Basin Area**, and **Figure B, New Basin Area and Proposed Storm Drain Pipelines.**

1- Hydrograph

a. The data and basin calculations are based on the hydrograph information provided by the City regarding the basin inflows during a 24-hour period and is illustrated in. **Graph A – Hydrograph - Base Flow (ft^3/s) vs Time** from time = 11.33 hours to 15.35 hours.

b. From the data provided by the City in the Hydrograph, the total flows into the Basin area are **7,510,287 CF** or **172 AF**



2- Basin Configuration and Design

a. The City wants this to contain the first ¾-inch flush to the basin on a 2 year storm which they have stated is 23 AF for the water quality storage volume based on the historical data collected.
b. Ideally, the basin should infiltrate within 72-hours to minimize habitat creation for vectors within the basin.
    i. Minimum infiltration rates required to drain the basin within 72 hours vary from 2.83 in/hr if the larger Case I basin is chosen, up to 3.67 in/hr if the smaller Case II basin is chosen which appears to be below the average infiltration rates for the area.
c. The maximum side slopes for the basin are 4 horizontal to 1 vertical (4:1). The mild slope of the sides will allow for the side and bottom to be maintained for mowing and trash removal as required by the City.
    i. The City desires to eliminate fencing around the basin which would detract from the multi use of the basin area by local hikers. Multiple 12:1 access roads along with the 4:1 side slopes will allow for multi-use by area hikers and City maintenance workers and equipment to the basin floor.
d. The design of the basin is based upon the procedures included in the Caltrans Project Planning and Design Guide and the California Storm water Quality Association (CASQA) BMP Fact Sheet TC-11.
e. Water quality basins often contain a smaller basin in-front of the water quality basin to serve as a stilling basin and these areas can also be equipped with a trash rack. Because of the depth of the basin is driven by the depth of the storm water inlet from 14th Street which sets the minimum basin floor elevation, as well as the existing 66-inch storm drain outlet at Benson Avenue which sets the minimum basin elevation for the water quality storage volume, construction of a higher elevation stilling basin and trash racks would greatly increase the overall depth of the water quality basin. Therefore, in order to minimize the total depth of the basin, the entire basin floor area will serve as a stilling basin and a water quality basin combined. Additionally, in this configuration, a trash rack would be difficult to install and for these types of trash racks, a crane would be required to access it for maintenance. However, by minimizing the side slopes and providing an access road to the basin floor, trash removal can be accomplished by the City's maintenance crew at regular intervals. Screened openings on the outlet structure would serve to retain the larger trash particles within the basin and prevent their flow to the downstream basins.
f. Multiple different basin configurations are being considered as follows:
    i. Case I maximizes the basin volume and utilizes the entire area west of 14th street and east of Benson Ave. There are significant existing utilities within the basin that must be relocated if this option is chosen. The preliminary top area of

the basin occupies an area of 271,097 sf and the bottom area of the basin occupies a preliminary area of 92,282 sf. This is shown in the Appendix in **Figure C, Case I – Large Basin Area**. At a 21-foot depth, this basin can store approximately 63.5 AF. At a 25-foot depth, this basin can store approximately 79.6 AF. **Table 1** below illustrates the **Storage Capacity vs. Basin Depth** for this configuration.

Table 1- Storage Capacity vs Basin Depth

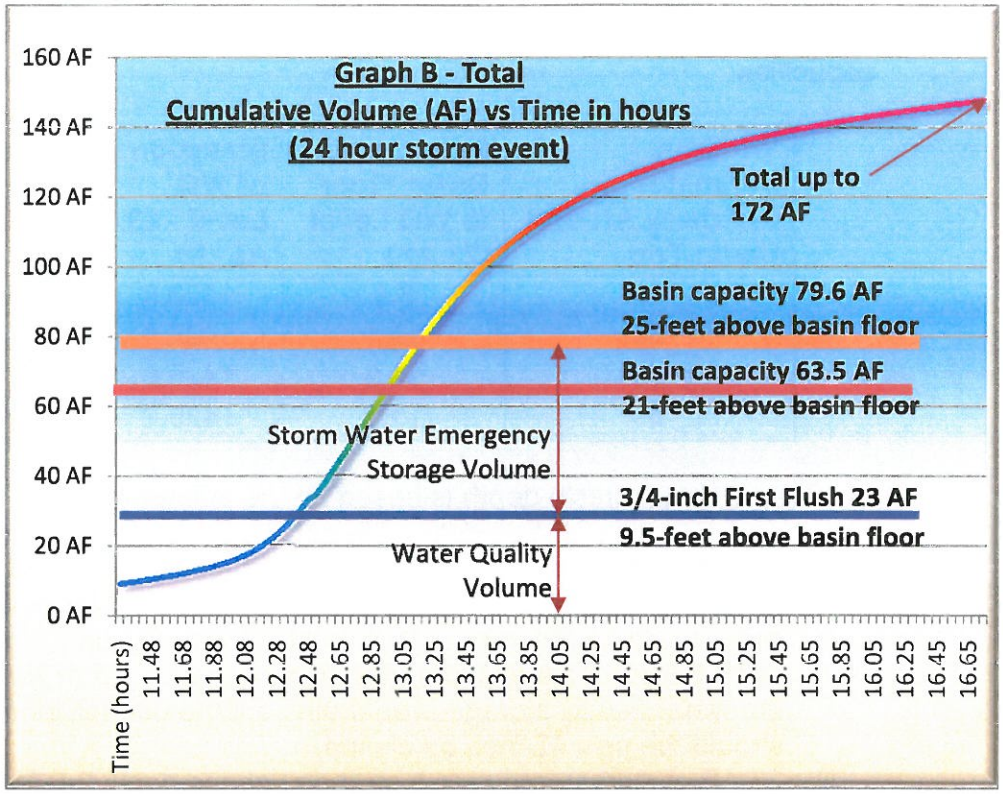
Volume-Acre feet	Depth (Invert) above Basin Floor - Feet
0.0	0.0
2.2	1.0
4.5	2.0
6.8	3.0
9.3	4.0
11.8	5.0
14.4	6.0
17.1	7.0
19.9	8.0
22.8	**9.0**
25.7	**10.0**
28.7	11.0
31.8	12.0
35.0	13.0
38.3	14.0
41.6	15.0
45.1	16.0
48.6	17.0
52.2	18.0
55.9	19.0
59.6	20.0
63.5	**21**
67.4	22.0
71.4	23.0
75.5	24.0
79.6	**25.0**

ii. CASE II minimizes the basin volume, and requires minimal utility relocation since the Eastern portion of the site is unoccupied by the basin. The top area of the basin occupies an area of 194,888 sf and the bottom area of the basin occupies an area of 59,046 sf. This is shown in the Appendix in **Figure D, Case II – Small Basin Area**. At a 25-foot depth, this basin can store approximately 58 AF.

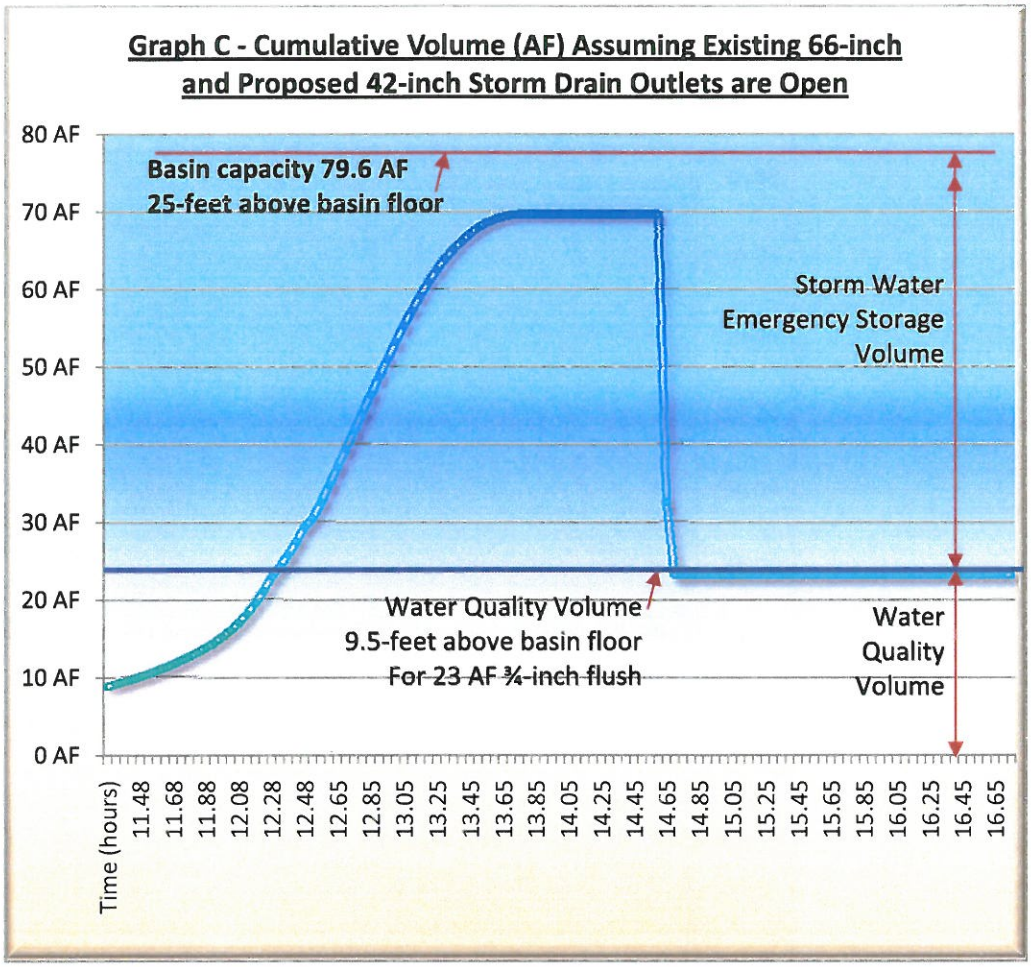
iii. Considering the preceding Case I and Case II examples, a more detailed design of the basin considering a 4:1 side slope revealed the following capacities:

Width of Perimeter Roadway Around Basin Top	Height from Basin Floor to WQ Level (23 AF)	Elevation of WQ Level - 23 AF (ft)	Overall Basin Capacity (AF)
20	8.8	1423.8	106.2
30	10.1	1425.1	93.6
40	11.6	1426.6	81.5
50	13.2	1428.2	70.0

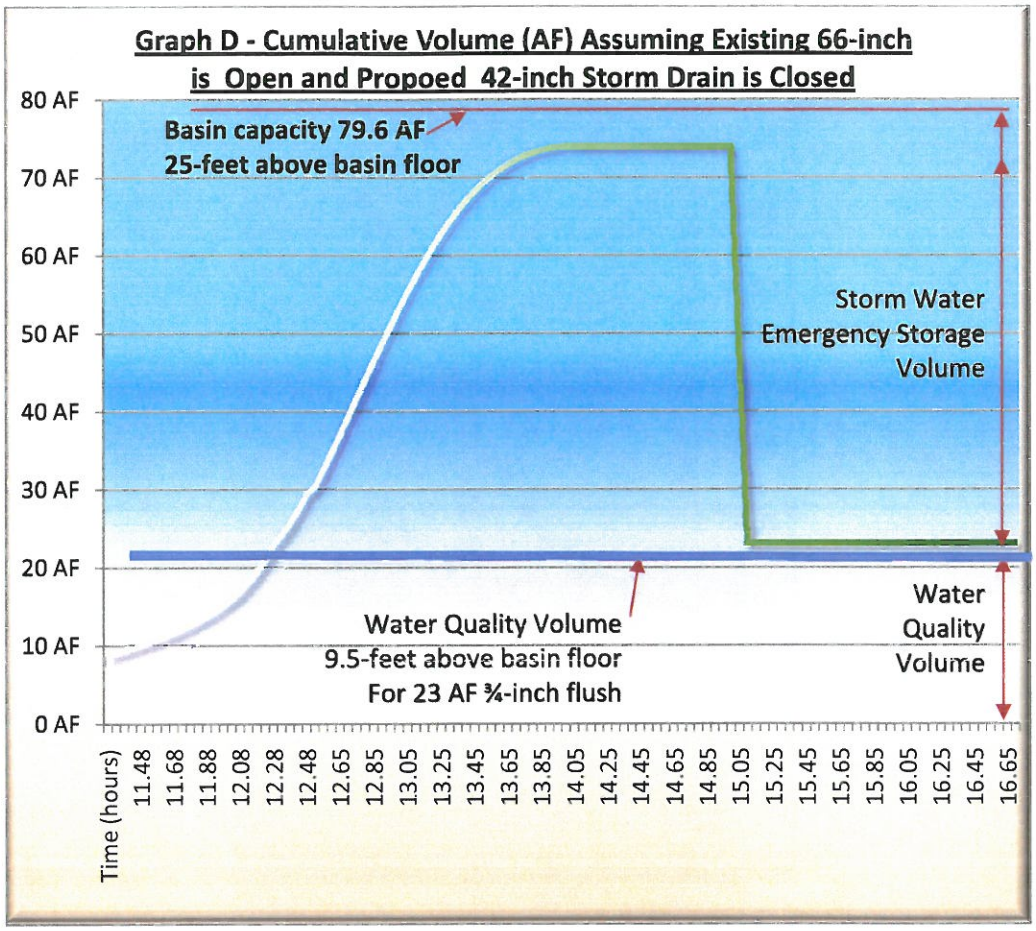
g. The minimum basin depth is based on the following:
   i. The elevation of the existing 66-inch and new 42-inch storm drain lines for the outlet in the west with invert elevations at 1419.80.
   ii. The minimum elevation to the top of the 23 AF water quality storage zone would be the invert of the existing 66-inch outlet storm drain, or 1419.80 feet. This ensures that the emergency storm zone above the water quality storage area drains out the 66-inch storm drain should the new 42-inch be closed.
   iii. 23 AF of storage requires a storage volume depth 9.5-feet above the basin invert.
   iv. The anticipated elevation of the new 84-inch inlet in the east from 14th street anticipated to be at 1423-feet. This makes the minimum basin depth assuming the top of the basin is at 1440-feet to be 17-feet deep. Note that the available storage volume of the 84-inch storm drain was not considered when calculating the required basin volumes.
   v. For the 24-hour storm event, assuming both the existing 66-inch storm drain outlet and the proposed 42-inch storm drain outlet are closed, the basin overruns. This is illustrated in the following **Graph B - Total Cumulative Volume (AF) vs Time in hours (24 hour storm event)**



For the 24-hour storm event, assuming both the existing 66-inch storm drain outlet and the proposed new 42-inch storm drain outlet are open and available to drain the basin as it fills above the water quality level, a minimum basin volume of 62.37 AF of storage area is required, which equates to a depth of 21-feet. In this scenario, the basin will not overflow since sufficient volume exists for storm water emergency storage. This is illustrated in the following **Graph C - Cumulative Volume (AF) Assuming Existing 66-inch and Proposed 42-inch Storm Drain Outlets are Open**.



For the 24-hour storm event, assuming both the existing 66-inch storm drain outlet is open and available to drain the basin as it fills above the water quality level and the proposed new 42-inch storm drain outlet is closed, a minimum basin volume of 66.72 AF of storage area is required, which equates to a depth of 22-feet. In this scenario, the basin will not overflow since sufficient volume exists for storm water emergency storage. This is illustrated in on the following page **Graph D - Cumulative Volume (AF) Assuming Existing 66-inch is Open and Proposed 42-inch Storm Drain Outlet is Closed**



However, the basin has insufficient capacity to drain without overflowing if only the proposed new 42-inch outlet is open, and the existing 66-inch outlet is closed. The volume required under this condition is 116 AF or approximately 45% more than a 25-foot deep basin could accommodate.

h. Since the top of the emergency overflow area on the SW corner of the basin at Benson Avenue is approximately elevation 1440-feet, it would be desirable to raise the grade of the southern edge adjacent to the City's Yard a few feet above this elevation to ensure the basin overflows to Benson Avenue.
i. The maximum storage elevation for the emergency high water level within the basin is 1445-feet, which is the same as the grade elevation at the terminus of 14th Street at the basin edge. However, setting the emergency storage high water level of the basin at 1445-feet would effectively render the proposed 84-inch storm drain within 14th Street full and would stop flowing. In this scenario, overflows from the basin would then be diverted to their current destination, down Mountain Avenue, as though the proposed 84-inch storm drain pipeline had not been installed.

j. With an anticipated water level of 1440, this is significantly higher than both the existing 66-inch outlet pipeline and the proposed 42-inch outlet pipeline. Given this condition, the outlet pipelines may be pressurized, and lift the manholes along Benson Avenue and beyond. Because of this, AECOM recommends that the manhole lids be bolted down.

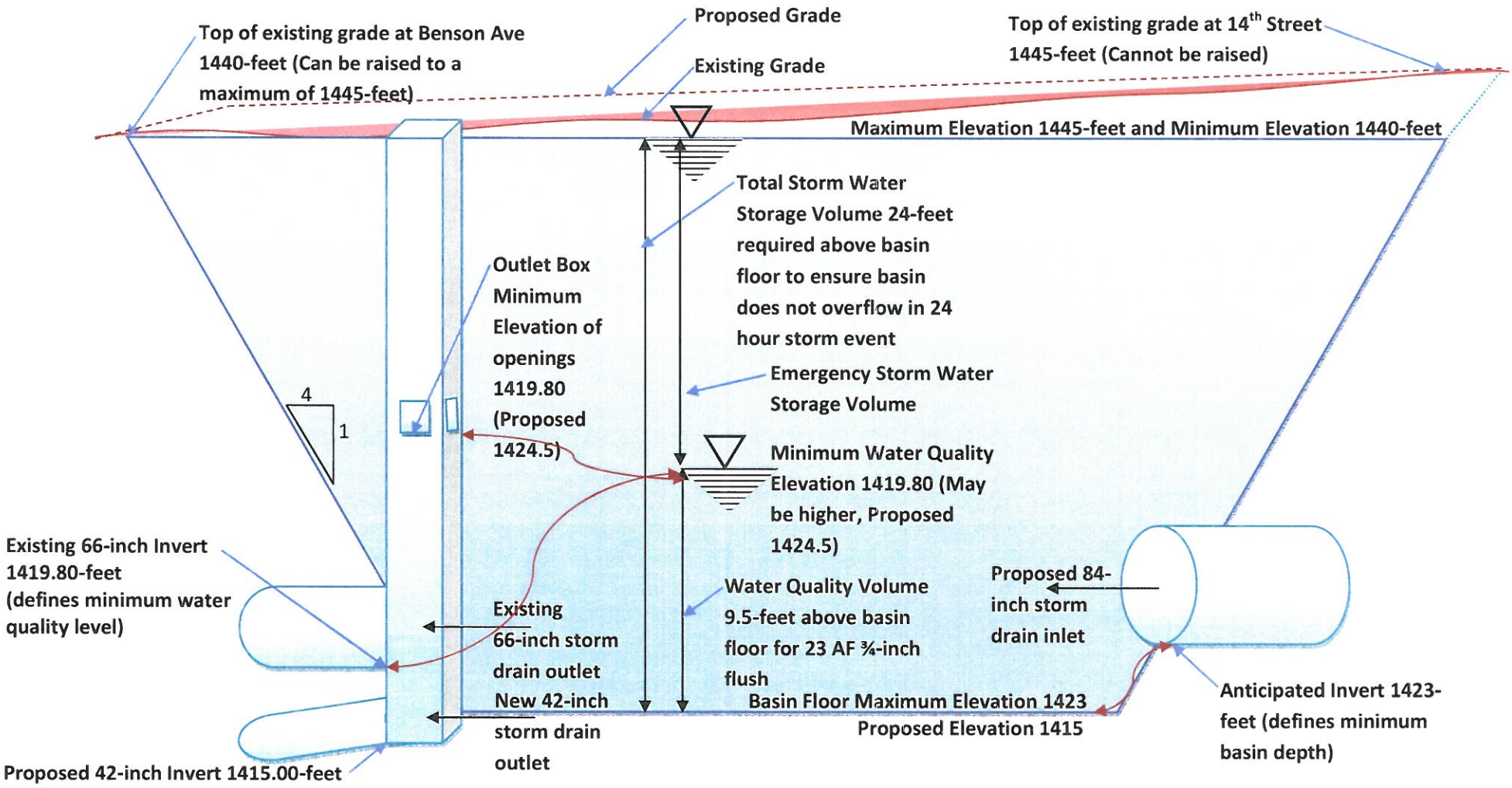
The above basin configuration items are shown in the graph on the following page, **Graph E – Basin Configuration Considerations**.

k. There are multiple existing utilities within the basin that will need to be relocated and these are shown in the Appendix in **Figure A, New Basin Area and Existing Utilities with the Basin Area**.
   i. There appears to be an existing 8-inch VCP sewer line that runs from the NE to the SE Corner of the site (480 lf)
   ii. There appears to be an existing 8-inch VCP sewer line that runs from Howard Access Road diagonally across to 14th St in the SE corner of the site (680 lf)
   iii. There appears to be an existing 6" water line from the end of Howard Access road running east and then turning south across the site (430-lf)
   iv. There appears to be a 16-inch water main and an 4-inch abandon water main running from the terminus of 14th Street due West more or less in the middle of the site (1100 lf)
   v. There appears to be a water line that runs from Howard Access road between Lots 6 and 7 running south to the middle of the site and then turning south-east through the remainder of the site (430-lf)

l. There are multiple overland flows that come into the project site that will require special detailing so as not to erode the side slopes of the basin. Riprap along these areas is anticipated to be sufficient to handle erosion from the overland flows. These are:
   i: Terminus of 14 St at the SE corner of the site.
   ii: NE and NW corners of the parking lot from Green Belt Park.
   iii: Two areas from the industrial development leading form Howard Access road along the northern edge of the basin.

3- Design Inlet Structure

a. The elevation of the inlet structure is based on the anticipated invert elevation of the proposed 84-inch pipeline in 14th street anticipated to be at 1423-feet but it could go as deep as 1415-feet. This structure will have grouted riprap for energy dissipation at the end of the pipeline. The final elevation of the inlet pipeline may be dropped to equal the level of the basin floor.



Graph E – Basin Configuration Considerations

4- 14th Storm drain inlet design

a. Approximately 2,000 LF of storm drain in 14th Street between Mountain Avenue and the basin should be sized for the Q100.
b. The storm drain is anticipated to be 84-inches in diameter with a ½% slope.
c. A large number of curb inlet catch basins required on Mountain Ave for the 538 CFS on the west side and 43 CFS on the east side of the street north of 14th Street. Catch basins will be located to avoid existing driveways, utilities, and trees whenever possible.
d. The design of the storm drain inlets will be based upon the methodology included in the Los Angeles County Department of Public Works Hydraulics Manual.

5- Benson Storm Drain Outlet Design

a. 1200-LF of proposed new 42-inch diameter RCP outlet pipe will connect the 14th Street Water Quality Regional Facility to the Upland Basin. The new storm drain will connect to an existing storm drain located in Benson Avenue at 13th Street. The connection point to the existing storm drain will be determined by the hydraulics and available capacity of the storm drain system.
b. The average slope is 0.317 but will be decreased to a slope of about 1% initially to minimize the depth of the new storm drain pipeline, and then follow the approximate slope of the existing road.
c. Velocities in the pipe may be as high as 22 feet per second. Because of this, the design may include velocity rings and additional concrete cover over the reinforcement.

6- Outlet Structure at Benson Ave

a. Since the City wishes to detain only the 23 AF associated with the ¾-inch first flush volume, any additional emergency storm water quantity beyond this volume would be temporarily stored within the basin and then diverted to one of two other basins via the existing 66-inch outlet pipeline to Holiday Pit or via the proposed new 42-inch outlet pipeline to the Upland Basin to the south.
b. The outlet structure of the basin at Benson Avenue will have limited capacity due to the existing storm drains downstream of the outlet structure. The approximate capacity of the existing storm drain outlet pipelines includes existing flows as follows:
    i. Considering only the average slope of the proposed new 42-inch pipeline going south on Benson Ave, the capacity of the storm drain outlet would be 195 cfs. However, the capacity of the existing 30-inch storm drain that the proposed new 42-inch pipeline would tie into is only 35 to 50 cfs. In consulting with the City's Storm Drain Model, a maximum capacity of 167 cfs was chosen for the flow rate into the proposed new 42-inch storm

drain that connects to the existing 30-inch storm drain. This is above the manning's calculation indicating the line is pressurized.

ii. The existing flow into the new 42-inch storm drain going south on Benson Ave peaks at approximately 326 cfs, well beyond the existing storm drain's capacity. Considering the existing flow, plus the required new flow to the new 42-inch storm drain, it appears that these flows overcome and overflow the system. In consulting with the City's storm drain model, in lieu of the 42" basin outlet pipeline, a new 66-inch pipeline from the outlet structure to 11th Street, half-way between Benson Avenue and Central Avenue, is required in addition to the existing storm drain system already in-place in order to handle the proposed flows. Otherwise, this storm drain system is overrun, and the storm drain overflows into Benson Ave, potentially lifting the manhole covers.

iii. In consulting with the City's storm drain model, the existing 66-inch storm drain pipeline predicted capacity is 325 cfs which is above the manning's calculation indicating the line is pressurized.

iv. Existing flows into existing 66-inch storm drain range up to 138.34 cfs based on the information provided by the City.

c. The bottom of outlet structure at Benson Avenue will match the lowest invert of the outlet pipeline at elevation1415 feet. This is shown in the Appendix in **Figure E – Proposed Outlet**. There will be:

i. Barred inlet boxes just above the 23 AF water quality level.

ii. An emergency outlet pipe near the bottom of the basin with a butterfly valve that can be opened to drain the basin should infiltration problems or an emergency situation arise.

iii. The 66-inch and 42-inch outlet pipelines will have gates which will have a riser stem to the top of the outlet box which the City could drive to and attach a power actuator onto them to open or close them.

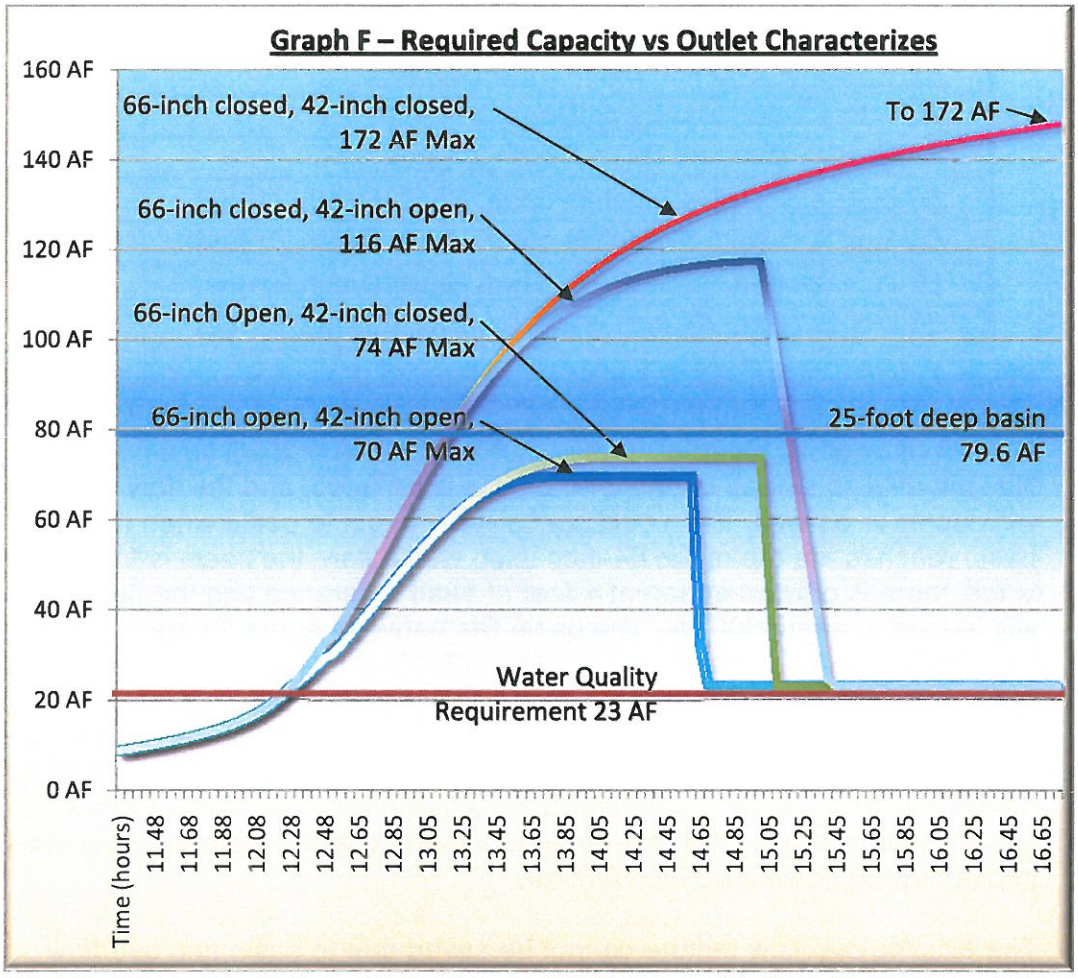
iv. Wing walls on the sides of the basin such that the City can drive maintenance vehicles over the top of the outlet pipelines and turn the gates at the outlet pipelines.

7- Overflow from Basin

a. The basin will hold additional volume above the required 23 AF of water quality storage. Under certain circumstances, the basin could overflow. It appears from consulting the hydrographs and the City's storm water models, that if this storm event occurs with the 66-inch storm drain closed to Holiday Pit, the basin will overflow.

b. The Overflow rate is dependent on the total basin capacity as well as the outlet characteristics from the basin. **Graph F- Required Capacity vs Outlet Characteristics** shown on the following page illustrates the

differing conditions when the 66-inch storm drain and 42-inch storm drain outlets are open or closed. From this graph, it can be seen that the only time the basin does not overflow is when the existing 66-inch storm drain is open, and the basin is 25-feet deep.



c. The City should consider lowering the depth of the 42-inch outlet storm drain below the 66-inch outlet storm drain. If the 42 is below the 66, then the gates could remain open all the time, but the basin to the south would begin filling first before the 66-inch storm drain to Holiday Pit. This would minimize overflow conditions by leaving both gates open under normal conditions so that normal flows can flow south via the new 42-inch storm drain to Upland Basin, and high storm water flows can always flow north to Holiday Pit via the existing 66-inch storm drain.

d. From the Hydrograph (Graph A), at the overflow times from Graph F, the anticipated overflow rate from the basin is shown under **Table 2 – Overflow Rate Without Considering Line Losses or Hydraulic Grade Line.**

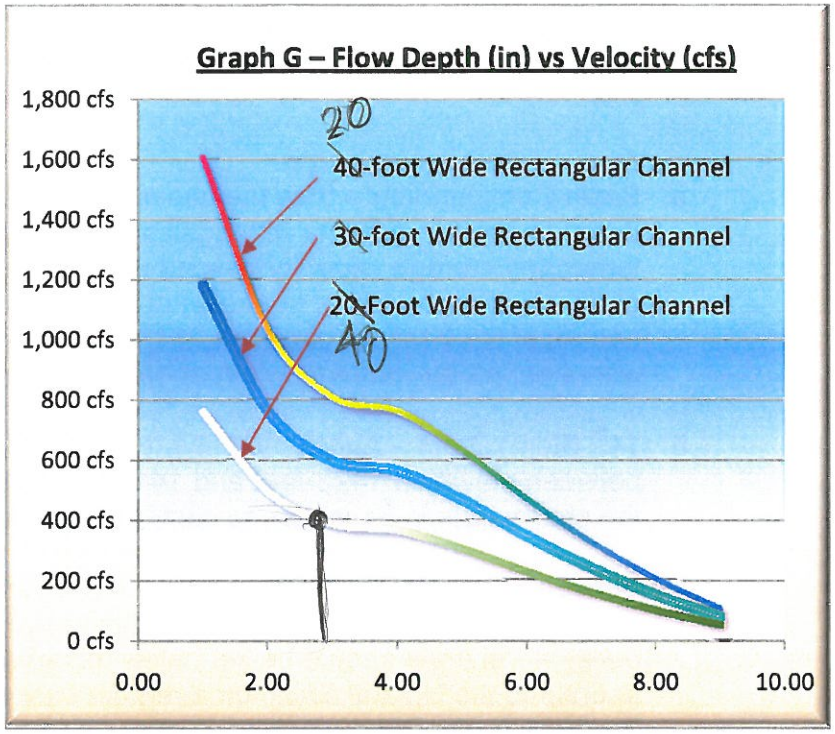
Table 2 – Overflow Rate Without Considering Line Losses or Hydraulic Grade Line	
	Overflow Rate (ft^3/s)
All Gates Closed and Basin Depth 21-feet	841
All Gates Closed and Basin Depth 25-feet	750
All Gates Open and Basin Depth 21-feet	689
All Gates Open and Basin Depth 25-feet	0.0
66-inch is closed, 42-inch is open, Basin Depth 21-feet	841
66-inch is closed, 42-inch is open, Basin Depth 25-feet	750
66-inch is open, 42-inch is closed, Basin Depth 21-feet	689
66-inch is open, 42-inch is closed, Basin Depth 25-feet	0.0

e. However when basin fills, the high water level in the basin approaches 1440, and the existing elevation at Mountain and 14th is 1444 at the curb. It should also be noted, that overflow down Mountain may occur in advance of a full basin, since as the basin fills, the available head on the 84-inch line is reduced, and the flow rate respectively will decrease as well. This could conceivably begin to occur when the level in the basin reaches the top of the 84-inch inlet, well before the basin is full. When the basin is full, there is only an apparent 4-feet of head difference and the flow in the 84-inch will reduce to about 300 cfs. The basin fills between hours 13 and 14, and peak flows from Mountain Avenue has well exceed 300 cfs at this point in time, so overflow has been occurring down Mountain Avenue for flows above the 300 cfs before the basin fills. Considering this when the basin is full, the flow from Green Belt Park is approximately an additional 100 cfs. Therefore, the combined maximum flow during overflow conditions that could feasibly reach the basin would be limited to approximately 400 cfs with the remainder of the overflow rate as shown in Table 2 above flowing down Mountain Avenue.

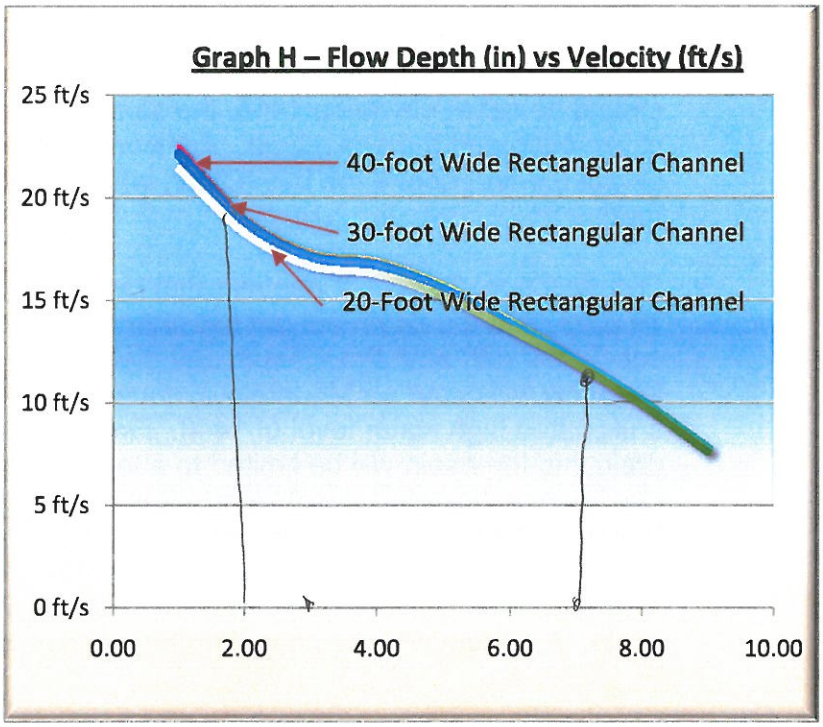
f. The existing overflow feature cannot be saved due to basin and overflow construction. Therefore a new overflow onto Benson Avenue will be designed. Of concern in handling the required overflow volumes is the velocity of the discharge onto Benson Avenue. As the discharge volume increases, so does the velocity and this could be a potential life safety hazard in an overflow condition. In designing the new overflow from the basin to Benson Avenue, the following parameters were considered:

   i. Rectangular Channel
   ii. Mannings, n 0.013
   iii. Longitudinal Slope (ft/ft) 0.02
   iv. Flow Rate $Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{0.5}$

g. **Graph G- Flow Depth (in) vs Velocity (cfs)** on the following page indicates the velocities for various flow rates.



h. **Graph H – Flow Depth (in) vs Flow Rate (ft/s)** indicates the various flow rates for a given geometry. Graph G and Graph H should be utilized concurrently in selecting the various parameters required for the overflow.



i. Considering Graph G and H above, it is evident that a 40-foot wide rectangular channel flowing 9.2-inches deep would satisfy the calculated flow of approximately 400 cfs with a velocity of about 13.2 ft/s.

8- Conclusions and Recommendations

a. Basin Configuration – Size the basin for 81.5 AF of volume (25-feet deep) to provide the City with additional emergency storm water temporary storage capacity beyond the required water quality volume of 23 AF. Set the top of the basin at elevation 1440-feet, and the bottom of the basin at elevation 1415-feet. The side slopes will be 4:1, with a perimeter roadway width of 40-feet around the basin top.

b. 14th Storm Drain – Anticipated invert of the 14th Street storm drain is between elevation 1423-feet and 1415-feet at the basin floor. Size of the storm drain is 84-inches to carry the required flow rate.

c. Benson Storm Drain Outlet Design – The invert of the existing 66-inch outlet storm drain is at 1419.80, and the crown of the new 42-inch outlet storm drain should be set below this elevation to enable the City to drain to the Upland Basin on a regular basis leaving both gates to the 66-inch and the 42-inch open under normal operating conditions. Setting the invert elevation of the 42-inch at the basin floor elevation of 1415-feet satisfies this criteria, and allows 1.3-feet of head to develop over the new 42-inch storm drain before flowing to the 66-inch storm drain.

d. Outlet Structure at Benson Ave – The bottom of the outlet structure should be set at elevation 1415, the same as the invert of the 42-inch storm drain and the basin floor. Additionally, the inlet openings should be set 9.5-feet above the basin floor, which would be elevation 1424.5-feet.

e. Overflow from Basin – It appears that by setting the basin volume to 79.6 AF, that the basin will not overflow under normal operating conditions with both the 42-inch and the 66-inch storm drains open. Overflow will occur on Mountain Avenue as the basin approaches the anticipated high water level of 1440. Flows from the 84-inch storm drain into the basin will be limited to about 300 cfs. It appears that the maximum anticipated overflow rate that can reach the basin both from Mountain Avenue / 14th Street and Green Belt Park area is approximately 400 cfs. Therefore, an overflow of 400 cfs seems appropriate for the overflow condition to Benson Avenue from the basin. A 40-foot wide rectangular channel flowing 9.2-inches deep

would satisfy the calculated flow of approximately 400 cfs with a velocity of about 13.2 ft/s

f. The system may overflow on Benson Avenue within the storm drain system. Therefore, pressure-type manhole covers should be used.

g. Benson Avenue Storm Drain to Upland Basin – Install a 66-inch storm drain from the basin outlet structure to connect in Benson Avenue to the 30-inch existing storm drain. While this will not alleviate the bottleneck of the undersized existing 30-inch storm drain system, this will minimize upstream re-work and provide the City with the appropriate storm drain size upstream of the existing 30-inch connection, should the City later decide to modify the existing downstream undersized storm drain system to 11th and Central.

Appendix