CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

CONTRACT NO. 201841403
PROJECT NAME: 38th & HOLLY DETENTION POND IMPROVEMENTS

ADDENDUM NO. 2 TO CONTRACT DOCUMENTS

Bidders are hereby instructed that the drawings, specifications, and other contract documents are modified, corrected, supplemented and/or superseded for the above mentioned project as hereinafter described in the following attachments:

Postponement of Bid Opening

City and County of Denver
Department of Public Works
Bid Postponement Notice

Contract No. 201841403
38th & Holly Detention Pond Improvements

Notice is hereby given that the Sealed Bid Opening for Contract No. 201841403—38th & Holly Detention Pond Improvements, is hereby postponed. Sealed bids will be received in Room 6.G.7., 201 W. Colfax Ave., Denver, CO 80202, no later than:

11:00am, local time
May 31st, 2018

Published in the Daily Journal on May 23, 24 and 25, 2018.

Questions and Answers

Q1- Will CAD files for the project could be made available?
A1- The CAD files will be made available to the awarded contractor.

Q2- We request a copy of the drainage report for the 38th & Holly Detention Pond Improvements.
A2 - Please see Attachment A to this Addendum No. 2

Q3- Is earthwork for contaminated material included in the specific bid item?
A3 - Item 3-8 Unclassified Excavation includes haul off of all material to DADs, unless contaminated material is encountered. If contaminated material is encountered, hauling of contaminated material will be paid for under item 3-2 Hauling of Contaminated Material to DADs.

Q4- Are there any known environmental issues with this site?
A4 - When the pond was originally constructed, asbestos contaminated buildings were demolished, and an asbestos cement sanitary service line was removed from the site. Environmental issues are not anticipated during the construction of this project. Per the Limited Environmental Evaluation for 38th and Holly Detention Pond memo completed by the City and County of Denver Environmental Quality Division, there is potential to encounter petroleum, solvent, and PCB impacted media during future improvement and construction activities at the Site.

Please refer to the memo included in the contract documents. However, during the initial construction of the pond, these were not encountered. A draft Materials Management Plan has been included in the contract documents.

Q5- Has a breakdown of the required excavation work been created or made available?
A5 - Per Item 3-8, it is estimated that 9600 CY of uncontaminated soil will be excavated and hauled off site. The contractor will be paid for the actual number of CY of soil excavated and hauled off site. If contaminated soil is encountered, hauling of this contaminated soil will be paid for per Item 3-2.

Q6- Is the 4,500 TON of contaminated material included / a portion of the 9,600 CY of unclassified excavation?
A6 - 9,600 CY is the total estimated excavation and haul off of material from the site to complete the project. Contaminated material is not anticipated, but 4,500 TON of contaminated materials was included in the event that the material is contaminated.

Q7- Is the uncontaminated portion of the 9,600 CY of unclassified excavation also to be hauled and disposed of at DAD's?
A7 - Yes, the uncontaminated portion of the 9,600 CY will be hauled and disposed of at DADs.

Q8- Is there asbestos in the pond liner?
A8- There is no pond liner and asbestos is not anticipated during construction.

Q9- If there is a potential for asbestos to be encountered during excavation, wouldn't it be necessary for a Certified Asbestos Building Inspector to be on site in order to identify the asbestos containing material?
A9 - Asbestos is not anticipated. However, Item 01-21.19.01 Certified Asbestos Inspector (CABI) was added to the bid tab in the event that asbestos is encountered.

Q10- Does there need to be a bid item for a Certified Asbestos Building Inspector?
A10 – See answer to question 9.

Q11- In reviewing the RFP documents provided, there is a lot of environmental info that suggests that there may be contamination issues at the reservoir site, however no environmental samples or borings were taken within the proposed excavation areas at the reservoir. Should the Contractor assume the need for a full time environmental specialist or CABI on-site during excavation activities to inspect for ACM or other contaminants to ensure proper waste disposal and worker protection is applied? Can the Statement of Quantities be revised to include a Pay Item for these services based on a daily rate or hourly rate with proper monitoring equipment and estimated quantity applied as it might be related to the proposed work schedule?
A11 – The Statement of Quantities has been revised to include item 01-21.19.01 Certified Asbestos Building Inspector (CABI)/ Air Monitor as an allowance account. See the Project Specific Construction Specification included in this addendum.

Q12- What bid item is the "Pond Inlet Structure" to be paid under on Sheet 245 of 38?
A12 – Pond Inlet Structure is to be paid under item 34-12.6 Cast-in-place Outfall Structure.

Q13- There seems to be some differences between the descriptions in the bid items and the descriptions / nomenclature used in the plans. Please indicate what details are associated with the following bid items:
CAST-IN-PLACE TYPE B MANHOLE SPECIAL DESIGN Add'l Info: WQ DIVERSION STRUCTURE
CAST-IN-PLACE OUTFALL STRUCTURE Add'l Info: HE OUTFALL PIPE
CAST-IN-PLACE SPECIAL STRUCTURE Add'l Info: WQ OUTLET STRUCTURE
DOUBLE #16 INLET WITH OPEN THROAT Add'l Info: IF NEEDED
ADJUST EXISTING INLET STRUCTURE

A13 – See question 17 for clarification regarding the Double #16 Inlet.

BidItem	Description	Additional Information	Structure Name on Plan Sheet 04
34-12.4c	CAST-IN-PLACE TYPE B MANHOLE SPECIAL DESIGN	WQ DIVERSION STRUCTURE	DIVERSION STRUCTURE
34-12.6	CAST-IN-PLACE OUTFALL STRUCTURE	HE OUTFALL PIPE	POND INLET STRUCTURE
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE	WQ OUTLET STRUCTURE	WATER QUALITY STRUCTURE W/ MICROPOOL

Q14- The measurement and payment for 3-2 "Hauling of Contaminated Materials to Denver/Arapahoe Disposal Site (DADS) states, "Payment shall be based upon weights obtained from a certified mobile scale, or at a location agreed to with the Construction Manager." Is the scale located at DAD's an acceptable location and method of measuring weight of hazardous material?
A14- Yes.

Q15- Bid item 2-11.5c – Abandon 12" Sewer has a note referring to 15" RCP. Please verify that this is the 15" pipe running east/west beneath Holly, between the #16 inlet and the 66" RCP.
A15- All records show that this is a 15" pipe. Unfortunately, we do not have a bid item for 15" pipe so the 15" pipe will be paid for under the 12" pipe bid item.

Q16- The profile section on sheet 07 shows to abandon the 15" Storm Sewer facility. Does this pipe need to be filled or just plugged at the ends (inlet and 66" RCP)?
A16- The whole length of the 15" pipe to be abandoned needs to be filled. This will be paid for under item 2-11.5c.

Q17- Bid item 2-13.1 – Remove Existing Double #16 Inlet – please verify that this is the inlet shown on the profile section of sheet 07, west of Holly. There is a note on this sheet indicating that we are to fill the inlet with grout - is this considered the removal of the inlet, and paid under bid item 2-13.1?
A17- The existing inlet to be filled with grout will be paid for under item 34-16.8 Adjust Existing Inlet Structure. We have included items 2-13.1 Remove Existing Storm Inlet and 34-16.3 Double #16 Inlet with Open Throat in the event that the condition of the existing inlet is poor and cannot be modified.

Q18- Bid item 2-11.9 – Abandon Existing Box Culvert. Do these box culverts need to be filled to be considered abandoned, or just plugged at the ends? If just plugged at the ends, are both ends required? It appears on sheet 04 that one end of each box culvert is located in a vault/manhole – are we to enter and build the plug within these vaults/manholes?
A18- The box culverts need to be plugged at both ends.

Q19- Bid item 2-11.9 also has a note referring to "and one 15" pipe". Is this the same 15" pipe referred to in bid item 2-11.5c? If so, is this a double-up on the work?
A19- Bid Item 2-11.5c will pay for abandoning the 15" pipe and item 2-11.9 will pay for plugging the box culverts. The additional information has been revised to reflect this.

Q20- Bid item 2-11.9 has a quantity of 40 LF. This quantity is difficult to comprehend. The remainder of the box culverts after the removals (bid item 2-11.7) leaves approximately 230 LF of box culvert to be abandoned. How was the quantity of 40 LF derived?
A20- It was assumed that each plug will be 10LF in length for a total of four plugs.

Q21- Bid item 8-1.1c – 8" DIP AWWA C151, Class 50 Water Line has a quantity of 100 LF. There is a Materials List on sheet WT-1 showing that only 46 LF is needed. Is there additional 8" water line elsewhere on the project?
A21- Item 8-1.1c is only for the waterline relocation. We often need to replace more than is shown on the water only plans so we include additional quantity in the event that we need to replace more.

Q22- The project appears to be waste project in terms of earthwork hauling. Is the excess dirt volume excavated required to be hauled and disposed of at DADS?

A22- Yes, if uncontaminated, excavation and hauling of excess dirt to DADs will be paid for under item 3-8 Unclassified Excavation. If the material is contaminated, hauling will be paid for under item 3-2 Hauling of Contaminated Material to DADs.

Q23- Are we to include disposal fees for the contaminated materials going to DADS?
A23- No, do not include disposal fees. The City and County of Denver will provide DADs disposal tickets

Q24- On sheet 06, the "Trickle Channel Typ. Section" indicates that the channel bottom varies from 4' to 10' wide, but to see the grading plan for local widths. Which sheet has the grading plan that calls out trickle channel widths?
A24- Trickle channel widths were not dimensioned on the grading plan but can be measured from the plan. If needed, a revised plan can be issued to the selected contractor.

Q25- In reference to the gabion baskets required on the project, there are several references to the wire type for the gabions. There are references to "finish 5, class 3", "5 gauge" and "stainless steel" (PDF page 346 of specs). We are not sure what "finish 5, class 3" is referring to. Galvanized wire is stocked in 9 or 11 gauge, and non-galvanized in 9 gauge for ArtWeld Gabions. Stainless wire can be supplied, if required, on special order. Please confirm wire type and gauge required on this project.
A25- Stainless steel 9 gauge is satisfactory.

Q26- With regards to the strip footings at the bottom of the drop structure walls, where do they get paid for? The walls, cap and reinforcement are indicated to be included in bid item 12-16a CONCRETE RETAINING WALL, but what about the wall footings? The two flatwork bid items (12-2.4) have notes that point me towards other items of work, so I do not believe it is paid there. Please verify where the slab footings are paid for.
A26- Item 12-16a, Concrete Retaining Wall, includes the wall footings.

Q27- The plan sheets jump from no. 02 to no. 04. Is there a plan sheet no. 03 that was inadvertently omitted or is there just a error in the plan sheet labeling?
A27-Plan sheet 03, Land Survey Control Diagram, was inadvertently omitted. The sheet is attached to this addendum.

Q28- Are you going to extend the contract duration from 120 days to something greater to accommodate timing the planting season widow?
A28-Yes, the contract duration will be extended as needed to accommodate planting season.

Q29- Will the City sign all manifests for the transport and disposal of regulated materials?
A29- Yes.

Q30- Is the contractor to bid the implementation of the draft MMP as if it is final?
A30- Yes.

Q31- Was any impacted media discovered during construction on this site between 2007 and current time? If so, what media was impacted, what was the level of impact, where was the media discovered, was it removed from site and is any impacted known to have been left on site?
A31- See question 4.

Q32- Will you provide more information about bid item 3-2 (Hauling of Contaminated Materials to DADs, 4,500 TONS). Is any contaminated material expected to be encountered? If so, what type of contaminated material?
A32-See questions 4 & 6 above.

Q33- Will the City indemnify the contractor regarding the handling and disposal of regulated materials?
A33- The City is the waste generator.

Q34- For the water line relocation, is the existing pipe asbestos lined?
A34-No, the existing pipe is 8" cast iron pipe.

Q35- Will the abandoned 6' x 4' CBC require us to flow fill?
A35- Yes, only at the capped ends. See questions 18-20 for more information.

Q36- Can the existing Rip Rap be reused?
A36- Yes, provided it meets the specs after removal.

Q37- Is this project subject to the 3-year warranty or the 1-year warranty per Article 1801, 4A?
A37- 3-year for all structures, pipes and flatwork, and 1-year for all landscape.

Q38- Is the contractor to provide meters or will these be provided by the owner?
A38-There is an existing meter and tap for the existing irrigation system. The existing irrigation system will be removed and replaced with the new irrigation system, and the existing tap and meter will be reused.

Q39- Is the Contractor or CCD responsible for tap fees?
A39-There is an existing tap so there is no tap fee.

Q40- Is on site power available for construction trailer hook-ups?
A40-No.

Q41- Specification 03 30 00-15, 3.13, Indicates to apply Anti-Graffiti coating to surfaces/elements indicated on drawings. There is no indication of Anti-Graffiti Coating indicated in the drawings. Please advise which surfaces/elements are to receive Anti-Graffiti Coating.
A41-Anti-graffiti coating is not necessary on any surfaces.

Q42- Per Specification 32 11 16-2, 2.2A, Is Recycled Concrete acceptable for the Aggregate Base Course?
A42-No.

Q43- Wetland Seed is indicated on the Planting Sheet (29 of 38), there is not a bid item on the Bid Form for Wetland Seed. Please advise.
A43-Wetland seed mix is included in item 329220-1 Seeding and Mulching-Non-irrigated.

Q44- Please confirm that it is the contractor's responsibility to obtain engineer stamped drawings for Bid Item 43-1b Storm Sewer Management.
A44-Yes.

Q45- Is a specific contractor and material required for the drop structure concrete shown on sheet 33 of 38?
   a. If not, will alternate materials be accepted?
A45-No. Materials must meet the intent of plans and specifications.

Q46- Does the Unclassified Excavation bid item include subgrade displacement?
A46- Unclassified excavation does not include subgrade displacement for construction of structures and pipe. It is the difference between the existing pond surface and the final pond surface.

Q47- Is export to be included in the Unclassified Excavation bid Item?
A47-See question 7.

Q48- The Unclassified Export Bid Item indicates to include topsoil Stockpiling but not topsoil spreading. Please Advise.
A48- Spreading of topsoil will be paid for under item 329113-1 Soil Preparation.

Q49- Is the 4500 tons of Contaminated Material export additional to the 9600 CY of Unclassified Excavation?
   a. If so, is it to be assumed that 4500 tons is to be deducted from the Unclassified Excavation?
A49-See questions 5-7.

Q50- Does the City and County of Denver have a site to accept the non-contaminated exported soil?
A50-DADs.

Q51- On Sheet 04 of 38 there is a note to Install 10'x16' Type L Soil Riprap (18" Thick) after removal of concrete pan. It does not appear that this area is accounted for in the provided quantity of Bid Item 30-1b Riprap Type L Soil Riprap (57 SY). Please advise.
A51-Bid item 30-1b Riprap Type L – Soil Riprap was increased to 90 SY.

Q52- Item 30-1a Riprap Type VL, indicates 24 SY. The only Type VL riprap shown in the drawings is on sheet 6 of 38 under the Boulder Check Structures. The provided quantity on the bid form is much greater than the necessary quantity indicated from the plans. Please advise.
A52-Yes, the quantity is an overrun.

Q53- Is bid item 34-12.6, Cast in Place Outfall Structure, intended to be the Inlet structure adjacent to the Forebay?
A53-Yes.

Q54- On sheet 4 of 38 of the Drawing Set, there is a note to reset Concrete Pad and 2 benches. On the provided bid form, there are 2 Bench pads indicated for item 12-2.3.

a. Please indicate the size and location of the second bench pad.
b. Is it the contractor's responsibility to set the benches?
    i. Is there a specification and required quantity of benches?

A54a-Each bench pad is 4LF by 8LF. They will be placed adjacent to each other in the location shown on sheet 04.
A54b- Yes.
A54bi- There are two existing benches that are to be reset per existing conditions. There is no spec.

Q55- On the provided Bid Form, there are items: 2-13.1 "Remove Existing Storm Inlet – Remove Double # 16 Inlet", 34-16.3a – "Double #16 Inlet with Open Throat – If Needed" and 34-16.8 "Adjust Existing Inlet Structure".

a. Please advise if all of these items correlate to each other.
b. If so, is the contractor to remove the existing storm inlet and replace it with a new one or is the contractor to adjust and modify the existing Double #16 inlet?

A55- See question 17.

Q56- Item 2-14 on the bid form indicates 832 CY (assumed one-foot depth) Riprap to be removed from the site. This quantity is much greater than areas indicated on the plans (sheet 04 of 38). Please advise.
A56- We included additional excavation in the event that there is unsuitable material.

Q57- Sheet 33 of 38 shows Specialty Paving Surfaces, but where the CBC is shown, there is a conflict as Sheet 19 and 20 do not show the specialty paving. Sheets 19 and 20 only show Class D concrete and Red Tile for Rumble Strip. Please advise the limits of the Specialty Paving Surface at the CBC (ie. Is the Specialty paving to continue through the CBC?)

a. Would it be possible to overlay the CBC on Sheet 33 of 38 to provide clarification?

A57- Specialty paving is intended to extend beneath the CBC. The surface on top of the box culvert will be Class D with Red Tile color for rumble strip. Also, see question 58.

Q58- Is a rendering or axonometric drawing of the proposed drop structure available for reference?
A58- Yes, a rendering has been included with this addendum.

Q59- On sheet 33 of the plan set, the second item in the legend is "Stamped Concrete Paving 'Cobble' Pattern by Brick Form (See Detail Sheet 13)". Sheet 13 does not have any details relating to this stamped concrete pattern – is this detail to be included in an addendum?
A59-The stamped concrete "Cobble" pattern, indicated on the Drop Structure Pavement Layout Diagram on Sheet 33, shall be the Brickform 6 in x 6 in "Edinburgh Cobble- Standard" stamp, Brickform Product ID FM-520, or approved equal. Concrete stamp shall be used according to manufacturer's recommended guidelines and shall be

applied within the limits shown in the Drop Structure Pavement Layout Diagram. Contractor shall stake layout of pattern and obtain approval of City Construction Project Manager prior to installing stamped concrete. The edges of the stamped concrete pattern shall be terminated with control joints where they transition to other concrete surfacing patterns.

Q60- Is the stamped concrete referenced above included in bid item 12-2.4 MISCELLANEOUS CONCRETE FLATWORK "Reinforced Concrete Drop Structure Paving"?
A60-Yes

Q61- Sheet 20 of 38 Detail C, indicates a Monolithic Pour for the walls and deck at the CBC. There is concern with safety and constructability of pouring this element monolithically. Can the walls and the deck be poured separately with construction joints at the walls and deck?

a. If a Construction Joints are allowed at the Walls and Deck, please advise if there are any specifications or details that need to be included for this joint?

A61-Yes. No specific details required.

Q62- Sheet 14 of 38 "Drop Structure Retaining Wall Typical section"

a. ½" Neoprene is indicated at the construction joint, is this typical for the Gabion Basket sections as well? Or only for the Wall?
b. What is the Durometer of the ½" Neoprene?

A62a- The ½" neoprene pad is only for the wall.
A62b- A durometer of 50 or 60 is acceptable.

Q63- Given the implications of the answers to these questions, can the bid date please be extended to provide additional time to vet and appropriately provide accurate pricing?
A63- Yes, the bid opening has been extended to May 31, 2018.

Q64- For bid item 12-2.4 MISCELLANEOUS CONCRETE FLATWORK, in regards to the "Reinforced Concrete Drop Structure Paving" bid item, what should the Contractor assume for reinforcement in this slab? On sheet 14, detail "Drop Structure Retaining Wall Typical Section" has a note that says "Slab Reinforcement See Sheet 16", but sheet 16 is comprised of details regarding the drop structure wingwalls.
A64-Sheet 15 shows the required slab reinforcement for the drop structure paving. Refer to sheet 14 for section locations.

Q65- For bid item 12-2.4 MISCELLANEOUS CONCRETE FLATWORK, in regard to the "Reinforced Concrete Drop Structure Paving" bid item, what is the thickness of the slab? On sheet 14, detail "Drop Structure Retaining Wall Typical Section", for the upper slab it shows 7" thick, and for the lower slab it shows 6" thick. Please verify.
A65- 7" is the required thickness of the drop structure slab. It does reduce to 6" at locations of the "low flow channel" see sheet 15 for clarification.

Q66- Is there a specified thickness for the plastic liner on top of gabions (sheet 16 of 38)?
A66- Yes, a minimum thickness of 0.031".

Q67- The handrail and base plate coating is specified as near white finish on sheet 23 of 38. However, Parks now specifies black paint. Will this apply to this project?
A67- Yes, the handrails and base plates will need to be painted using Tnemec Paint in Black.

Q68- Bid item 30-2b GROUTED BOULDERS (3-FOOT DIAMETER). The section detail "Boulder Check Structure" on sheet 06 is misleading, as it shows boulders that are called out as 36" MIN on the outsides of the boulder check structures, and boulders that appear to be much smaller on the inside of the check structure. Additionally, using the section detail "Trickle Channel Typ. Section" on sheet 06, it can be deduced that the widest the trickle channel can be is 10', plus 1'-6" on either side for the bank, for a total of 13' wide maximum. Using 36" MIN boulders, this would only require 4 – 5 boulders per check structure, as opposed to the detail showing 10 boulders, and would significantly change the shape of the boulder check structure having to create a low-flow channel with only 5 boulders. Please verify that all boulders across the boulder check structures shall be 36" MIN diameter.
A68- Only the two boulders on each end need to be minimum 36". When you request 36" boulders, you typically get a range of sizes (i.e. everything isn't exactly 36"). The detail shows a general recommendation for the variation in rock sizes.

Q69- Bid item 30-2b GROUTED BOULDERS (3-FOOT DIAMETER) uses the word "grouted" in the bid item title, yet there are no references to grouting these boulders in the plans, or details as to how thick the grout must be, the extent of the grout, etc. "Boulder Check Structure" detail on sheet 06 appears to show Type VL riprap to the top of the boulders and does not show grout. Please verify that grouted riprap is what is desired, and if so, please provide additional details for grouting the boulders.
A69- Grout is not desired. The additional information on the bid tab has been updated to reflect this.

Q70- Looking at the specifications (attached), it appears that either galvanized or galfan, per 712.09, is allowed, but below that in (b), it references "hard drawn stainless steel wire". Is there a preference? Additionally, the plans are referencing baskets that are not typical, standard sizes. Is there any ability to modify the wingwalls to allow for more standard size gabions or will the installer be allowed to use roll-stock instead of the typical, pre-formed baskets? Finally, I see that welded-wire baskets are being specified, but are hexagonal, double-twist gabions a consideration as well?
A70 – Hard drawn stainless steel welded-wire with 3 inch grid is preferred to achieve the project team's aesthetic goals. The baskets will need to be pre-formed baskets and will need to meet the sizes specified in the plans.

Q71- Is survey staking to be performed by the contractor or will it be performed by City surveyors?
A71-Survey staking is to be completed by the City surveyors and has therefore been removed from the bid tab included in this addendum.

Revised and/or Added Documents

Attachment A: Revised Schedule A Bid Form

Attachment B: Revised Schedule A Statement of Quantities

Attachment C: Construction Specification for a CABI

Attachment D: Proposed Pond Rendering

Attachment E: Sheet 03-Survey Control Diagram which was inadvertently omitted

Attachment F: Sheets 34-38 which were inadvertently labeled as "not for construction" in the bid set

Attachment G: Final Drainage Memo and Design Calculations

This **ADDENDUM** shall be attached to, become a part of, and be returned with the Bid Proposal.

Lesley B. Thomas
City Engineer
5.22.18
Date

The undersigned bidder acknowledges receipt of this Addendum. The Proposal submitted herewith is in accordance with the stipulations set forth herein.

_____
Contractor

ADDENDUM NO. 2 DATE: _____

Attachment A to Addendum No. 2, 201841403

Revised Schedule A Bid Form

Bid Form

Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
01-21.19.01	**ALLOWANCE FOR CERTIFIED ASBESTOS BUILDING INSPECTOR (CABI)/AIR MONITOR(HOURLY) - SEE PROJECT SPECIAL PROVISIONS** at the unit price of $50,000 true and verifiable costs + mark up	1	A/A	***$50,000***
2-1.2a	**REMOVE 6" CONCRETE CURB AND/OR GUTTER** *Add'l Info: ALONG HOLLY* at the unit price of $ per linear foot	30	LF	***$***
2-1.4	**REMOVE HANDICAP CONCRETE CURB RAMP** *Add'l Info: NW CORNER OF 38TH & HOLLY* at the unit price of $ per square foot	95	SF	***$***
2-2.1	**REMOVE CONCRETE SIDEWALK** *Add'l Info: INCLUDES BENCH PADS* at the unit price of $ per square foot	9,180	SF	***$***
2-2.2	**REMOVE CONCRETE DRIVEWAY PAVING** at the unit price of $ per square foot	222	SF	***$***
2-2.4	**REMOVE CONCRETE CHANNEL PAVING** *Add'l Info: 8' WIDE TRICKLE CHANNEL* at the unit price of $ per square foot	4,830	SF	***$***
2-2.4	**REMOVE CONCRETE CHANNEL PAVING** *Add'l Info: 36'X2'* at the unit price of $ per square foot	74	SF	***$***

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
2-6	**REMOVE CONCRETE HEADWALL** *Add'l Info: EXISTING OUTFALL* at the unit price of $ _____ each	1	EA	$
2-6	**REMOVE CONCRETE HEADWALL** *Add'l Info: EXISTING 6'X4' INLET* at the unit price of $ _____ each	1	EA	$
2-11.5c	**ABANDON EXISTING 12" SEWER PIPE** *Add'l Info: ABANDON 15" RCP* at the unit price of $ _____ per linear foot	28	LF	$
2-11.7	**REMOVE EXISTING BOX CULVERT** *Add'l Info: EXISTING 6'X4'* at the unit price of $ _____ per linear foot	24	LF	$
2-11.9	**ABANDON EXISTING BOX CULVERT** *Add'l Info: PLUG AND ABANDON EACH END OF TWO BOX CULVERTS* at the unit price of $ _____ per linear foot	40	LF	$
2-12.7	**REMOVE EXISTING STRUCTURE** *Add'l Info: EXISTING POND OUTLET STRUCTURE* at the unit price of $ _____ each	1	EA	$
2-13.1	**REMOVE EXISTING STORM INLET** *Add'l Info: IF NEEDED-REMOVE DOUBLE #16 INLET* at the unit price of $ _____ each	1	EA	$
2-14	**REMOVE RIPRAP** *Add'l Info: ASSUMED 1' RIPRAP THICKNESS* at the unit price of $ _____ per cubic yard	832	CY	$

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
02-22.13	**VIBRATION ASSESSMENT** at the unit price of $ _____ lump sum	1	LS	$
3-2	**HAULING OF CONTAMINATED MATERIALS TO DENVER/ ARAPAHOE DISPOSAL SITE (DADS)** at the unit price of $ _____ per ton	4,500	TON	$
3-7a	**HEALTH & SAFETY PLAN** at the unit price of $ _____ lump sum	1	LS	$
3-7b	**MATERIAL MANAGEMENT PLAN** at the unit price of $ _____ lump sum	1	LS	$
3-8	**UNCLASSIFIED EXCAVATION** *Add'l Info: INCLUDES STOCKPILING OF TOPSOIL* at the unit price of $ _____ per cubic yard	9,600	CY	$
5-1	**STRUCTURAL FILL** at the unit price of $ _____ per ton	600	TON	$
5-2a	**SUBGRADE MATERIAL (SELECT BACKFILL)** *Add'l Info: CLASS 67 MATERIAL - BEDDING FOR ALL STRUCTURES* at the unit price of $ _____ per ton	200	TON	$
8-1.1c	**8" DIP AWWA C151, CLASS 50 WATER LINE** *Add'l Info: INCLUDES REMOVAL OF 8" CAST IRON PIPE* at the unit price of $ _____ per linear foot	100	LF	$
8-1.2c	**INSTALL 8" WATER VALVE** *Add'l Info: IF NEEDED* at the unit price of $ _____ each	4	EA	$

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
8-1.3a	**4" PVC AWWA C900, CLASS 200** *Add'l Info: FOR WQ MONITORING* at the unit price of $ _____ per linear foot	200	LF	$ _____
8-2	**REMOVE FIRE HYDRANT ASSEMBLY** *Add'l Info: IF REQUESTED BY DENVER WATER* at the unit price of $ _____ each	1	EA	$ _____
8-3	**RESET OR INSTALL FIRE HYDRANT ASSEMBLY** *Add'l Info: IF REQUESTED BY DENVER WATER* at the unit price of $ _____ each	1	EA	$ _____
12-1.1	**6" CURB AND GUTTER 2' PAN (CD0T T2, IIB)** at the unit price of $ _____ per linear foot	50	LF	$ _____
12-1.8	**HANDICAP CONCRETE CURB RAMP** *Add'l Info: NW CORNER OF 38TH & HOLLY* at the unit price of $ _____ per square foot	200	SF	$ _____
12-2.3	**CONCRETE BIKE PATH** *Add'l Info: INCLUDES 2 BENCH PADS* at the unit price of $ _____ per square foot	15,000	SF	$ _____
12-2.4	**MISCELLANEOUS CONCRETE FLATWORK** *Add'l Info: CONCRETE FOREBAY* at the unit price of $ _____ per square foot	1,651	SF	$ _____
12-2.4	**MISCELLANEOUS CONCRETE FLATWORK** *Add'l Info: REINFORCED CONCRETE DROP STRUCTURE PAVING* at the unit price of $ _____ per square foot	3,267	SF	$ _____

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity			Estimated Cost
12-5.1	**CONCRETE DRIVEWAY PAVING** *Add'l Info: ACCESS DRIVEWAY TO OUTLET* at the unit price of $ _____ per square foot	3,302	SF	$	
12-5.1	**CONCRETE DRIVEWAY PAVING** *Add'l Info: ACCESS DRIVEWAY TO INLET* at the unit price of $ _____ per square foot	2,180	SF	$	
12-16a	**CONCRETE RETAINING WALL** *Add'l Info: CONCRETE FOREBAY WALL (2 CY)* at the unit price of $ _____ lump sum	1	LS	$	
12-16a	**CONCRETE RETAINING WALL** *Add'l Info: CONCRETE DROP WALL AROUND GABIONS (132 CY) INCLUDES WALL, CAP & REINFORCEMENT* at the unit price of $ _____ lump sum	1	LS	$	
20-5	**ASPHALT PATCH** *Add'l Info: 9" DEPTH* at the unit price of $ _____ per square yard inch	1,600	SY-IN	$	
30-1a	**RIPRAP TYPE VL** *Add'l Info: TRICKLE CHANNEL CHECK STRUCTURE* at the unit price of $ _____ per square yard	24	SY	$	
30-1b	**RIPRAP TYPE L** *Add'l Info: FOREBAY* at the unit price of $ _____ per square yard	61	SY	$	
30-1b	**RIPRAP TYPE L** *Add'l Info: TRICKLE CHANNEL* at the unit price of $ _____ per square yard	108	SY	$	

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
30-1b	**RIPRAP TYPE L** *Add'l Info: SOIL RIPRAP* at the unit price of $ _____ per square yard	90	SY	$ _____
30-2b	**GROUTED BOULDERS (3-FOOT DIAMETER)** *Add'l Info: BOULDER CHECK STRUCTURES-NOT GROUTED* at the unit price of $ _____ per square yard	16	SY	$ _____
30-3	**ROCK FILLED GABIONS** *Add'l Info: SEE SUPPLEMENTAL TECHNICAL SPECIFICATIONS AND MEASUREMENT AND PAYMENT *CY MEASURE** at the unit price of $ _____ per cubic yard	175	CY	$ _____
34-5.4i	**38" X 60" C-507 RCP, CLASS HE-III** at the unit price of $ _____ per linear foot	119	LF	$ _____
34-6.1	**BOX CULVERT - CAST-IN-PLACE** *Add'l Info: 10'X2' RCBC* at the unit price of $ _____ per linear foot	56	LF	$ _____
34-7.1c	**12" DIAMETER PVC PIPE** *Add'l Info: SDR 35 STORM PIPE, INLET TO DROP* at the unit price of $ _____ per linear foot	71	LF	$ _____
34-12.4c	**CAST-IN-PLACE TYPE B MANHOLE SPECIAL DESIGN** *Add'l Info: WQ DIVERSION STRUCTURE* at the unit price of $ _____ each	1	EA	$ _____
34-12.6	**CAST-IN-PLACE OUTFALL STRUCTURE** *Add'l Info: HE OUTFALL PIPE (POND INLET STRUCTURE)* at the unit price of $ _____ each	1	EA	$ _____

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
34-12.7	**CAST-IN-PLACE SPECIAL STRUCTURE** *Add'l Info: WQ OUTLET STRUCTURE* at the unit price of $ _____ each	1	EA	$
34-15.3	**UTILITY EXPLORATORY INVESTIGATION** at the unit price of $ _____ each	5	EA	$
34-16.3a	**DOUBLE #16 INLET WITH OPEN THROAT** *Add'l Info: IF NEEDED* at the unit price of $ _____ each	1	EA	$
34-16.8	**ADJUST EXISTING INLET STRUCTURE** at the unit price of $ _____ each	1	EA	$
41-1	**TRAFFIC CONTROL** at the unit price of $ _____ lump sum	1	LS	$
43-1b	**STORM WATER MANAGEMENT (SCENARIO 2) See SCS 23.0** at the unit price of $ _____ lump sum	1	LS	$
44-1	**DEWATERING** at the unit price of $ _____ lump sum	1	LS	$
45-2	**QUALITY CONTROL TESTING** at the unit price of $ _____ lump sum	1	LS	$
46-2	**EPOXY PAVEMENT MARKING** at the unit price of $ _____ per square foot	10	SF	$
50-1	**MOBILIZATION** at the unit price of $ _____ lump sum	1	LS	$

Bid Items Total Amount (01-21.19.01 through 50-1 (Fifty-Eight [58]) total bid items) Schedule A: $ _____

Bid Items Total Amount (024100-1 through 329700-1 (Forty-Seven [47]) total bid items) Schedule B: $ _____

Textura ® Fee from table on Page BF-3 (based on combined Schedule A and Schedule B Bid Items Total Amount) $ _____

Bid Items Total Amount combined Schedule A, and Schedule B plus Textura® Fee equals Total Bid Amount $ _____

Total Bid Amount:
_____
_____
_____**Dollars ($_____)**

If the Manager mails a written Notice of Apparent Low Bidder, addressed to the Bidder's business address stated on this Bid Form, the Undersigned Bidder shall, in accordance with the Contract Documents, be ready to, and shall, within five (5) days after the date of the Notice: (i) execute the attached form of Contract in conformity with this bid; (ii) furnish the required proofs of insurance; and (iii) furnish the required bond or bonds in the sum of the full amount of this bid, executed by a surety company acceptable to the Manager.

The _____, a corporation of the State of _____, is hereby offered as Surety on said bond. If such surety is not approved by the Manager, another and satisfactory surety company shall be furnished.

Enclosed with this bid is a bid guarantee, as defined in the attached Instructions to Bidders, in the amount of _____. The Undersigned Bidder agrees that the entire amount of this bid guarantee is to be paid to and become the property of the City as liquidated damages, and not as a penalty, if: (i) the bid is considered to be the best by the City; (ii) the City notifies the Undersigned Bidder that it is the Apparent Low Bidder; and (iii) the Undersigned Bidder fails to execute the Contract in the form prescribed or to furnish the required bond and proofs of insurance, within five (5) days after the date of such notification.

The following persons, firms or corporations are interested with the Undersigned Bidder in this bid:

Name: _____ Name: _____

Address: _____ Address: _____

If there are no such persons, firms, or corporations, please so state in the following space:

Attachment B to Addendum No. 2, 201841403

Revised Schedule A Statement of Quantities

Statement of Quantities

WQ REG - 38th & Holly Pond Rehab

Schedule A

Pay Item #	Description	Estimated Quantity	Units
1- 21.19.01	ALLOWANCE FOR CERTIFIED ASBESTOS BUILDING INSPECTOR (CABI)/AIR MONITOR(HOURLY) - SEE PROJECT SPECIAL PROVISIONS	1	A/A
2- 1.2a	REMOVE 6" CONCRETE CURB AND/OR GUTTER *Add'l Info: ALONG HOLLY*	30	LF
2-1.4	REMOVE HANDICAP CONCRETE CURB RAMP *Add'l Info: NW CORNER OF 38TH & HOLLY*	95	SF
2-2.1	REMOVE CONCRETE SIDEWALK *Add'l Info: INCLUDES BENCH PADS*	9,180	SF
2-2.2	REMOVE CONCRETE DRIVEWAY PAVING	222	SF
2-2.4	REMOVE CONCRETE CHANNEL PAVING *Add'l Info: 8' WIDE TRICKLE CHANNEL*	4,830	SF
2-2.4	REMOVE CONCRETE CHANNEL PAVING *Add'l Info: 36'X2'*	74	SF
2-6	REMOVE CONCRETE HEADWALL *Add'l Info: EXISTING OUTFALL*	1	EA
2-6	REMOVE CONCRETE HEADWALL *Add'l Info: EXISTING 6'X4' INLET*	1	EA
2-11.5c	ABANDON EXISTING 12" SEWER PIPE *Add'l Info: ABANDON 15" RCP*	28	LF
2-11.7	REMOVE EXISTING BOX CULVERT *Add'l Info: EXISTING 6'X4'*	24	LF
2-11.9	ABANDON EXISTING BOX CULVERT *Add'l Info: PLUG AND ABANDON EACH END OF TWO BOX CULVERTS*	40	LF

Pay Item #	Description	Estimated Quantity	Units
2-12.7	REMOVE EXISTING STRUCTURE *Add'l Info: EXISTING POND OUTLET STRUCTURE*	1	EA
2-13.1	REMOVE EXISTING STORM INLET *Add'l Info: IF NEEDED-REMOVE DOUBLE #16 INLET*	1	EA
2-14	REMOVE RIPRAP *Add'l Info: ASSUMED 1' RIPRAP THICKNESS*	832	CY
2- 22.13	VIBRATION ASSESSMENT	1	LS
3- 2	HAULING OF CONTAMINATED MATERIALS TO DENVER/ ARAPAHOE DISPOSAL SITE (DADS)	4,500	TON
3-7a	HEALTH & SAFETY PLAN	1	LS
3-7b	MATERIAL MANAGEMENT PLAN	1	LS
3-8	UNCLASSIFIED EXCAVATION *Add'l Info: INCLUDES STOCKPILING OF TOPSOIL*	9,600	CY
5-1	STRUCTURAL FILL	600	TON
5-2a	SUBGRADE MATERIAL (SELECT BACKFILL) *Add'l Info: CLASS 67 MATERIAL - BEDDING FOR ALL STRUCTURES*	200	TON
8-1.1c	8" DIP AWWA C151, CLASS 50 WATER LINE *Add'l Info: INCLUDES REMOVAL OF 8" CAST IRON PIPE*	100	LF
8-1.2c	INSTALL 8" WATER VALVE *Add'l Info: IF NEEDED*	4	EA
8-1.3a	4" PVC AWWA C900, CLASS 200 *Add'l Info: FOR WQ MONITORING*	200	LF
8-2	REMOVE FIRE HYDRANT ASSEMBLY *Add'l Info: IF REQUESTED BY DENVER WATER*	1	EA
8-3	RESET OR INSTALL FIRE HYDRANT ASSEMBLY *Add'l Info: IF REQUESTED BY DENVER WATER*	1	EA

Pay Item #	Description	Estimated Quantity	Units
12-1.1	6" CURB AND GUTTER 2' PAN (CD0T T2, IIB)	50	LF
12-1.8	HANDICAP CONCRETE CURB RAMP *Add'l Info: NW CORNER OF 38TH & HOLLY*	200	SF
12-2.3	CONCRETE BIKE PATH *Add'l Info: INCLUDES 2 BENCH PADS*	15,000	SF
12-2.4	MISCELLANEOUS CONCRETE FLATWORK *Add'l Info: CONCRETE FOREBAY*	1,651	SF
12-2.4	MISCELLANEOUS CONCRETE FLATWORK *Add'l Info: REINFORCED CONCRETE DROP STRUCTURE PAVING*	3,267	SF
12-5.1	CONCRETE DRIVEWAY PAVING *Add'l Info: ACCESS DRIVEWAY TO OUTLET*	3,302	SF
12-5.1	CONCRETE DRIVEWAY PAVING *Add'l Info: ACCESS DRIVEWAY TO INLET*	2,180	SF
12-16a	CONCRETE RETAINING WALL *Add'l Info: CONCRETE FOREBAY WALL (2 CY)*	1	LS
12-16a	CONCRETE RETAINING WALL *Add'l Info: CONCRETE DROP WALL AROUND GABIONS (132 CY) INCLUDES WALL, CAP & REINFORCEMENT*	1	LS
20-5	ASPHALT PATCH *Add'l Info: 9" DEPTH*	1,600	SY-IN
30-1a	RIPRAP TYPE VL *Add'l Info: TRICKLE CHANNEL CHECK STRUCTURE*	24	SY
30-1b	RIPRAP TYPE L *Add'l Info: FOREBAY*	61	SY
30-1b	RIPRAP TYPE L *Add'l Info: TRICKLE CHANNEL*	108	SY

Pay Item #	Description	Estimated Quantity	Units
30-1b	RIPRAP TYPE L *Add'l Info: SOIL RIPRAP*	90	SY
30-2b	GROUTED BOULDERS (3-FOOT DIAMETER) *Add'l Info: BOULDER CHECK STRUCTURES-NOT GROUTED*	16	SY
30-3	ROCK FILLED GABIONS *Add'l Info: SEE SUPPLEMENTAL TECHNICAL SPECIFICATIONS AND MEASUREMENT AND PAYMENT *CY MEASURE**	175	CY
34-5.4i	38" X 60" C-507 RCP, CLASS HE-III	119	LF
34-6.1	BOX CULVERT - CAST-IN-PLACE *Add'l Info: 10'X2' RCBC*	56	LF
34-7.1c	12" DIAMETER PVC PIPE *Add'l Info: SDR 35 STORM PIPE, INLET TO DROP*	71	LF
34-12.4c	CAST-IN-PLACE TYPE B MANHOLE SPECIAL DESIGN *Add'l Info: WQ DIVERSION STRUCTURE*	1	EA
34-12.6	CAST-IN-PLACE OUTFALL STRUCTURE *Add'l Info: HE OUTFALL PIPE (POND INLET STRUCTURE)*	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE *Add'l Info: WQ OUTLET STRUCTURE*	1	EA
34-15.3	UTILITY EXPLORATORY INVESTIGATION	5	EA
34-16.3a	DOUBLE #16 INLET WITH OPEN THROAT *Add'l Info: IF NEEDED*	1	EA
34-16.8	ADJUST EXISTING INLET STRUCTURE	1	EA
41-1	TRAFFIC CONTROL	1	LS
43-1b	STORM WATER MANAGEMENT (SCENARIO 2) See SCS 23.0	1	LS

Pay Item #	Description	Estimated Quantity	Units
44-1	DEWATERING	1	LS
45-2	QUALITY CONTROL TESTING EPOXY	1	LS
46-2	PAVEMENT MARKING	10	SF
50-1	MOBILIZATION	1	LS

Attachment C to Addendum No. 2, 201841403

Construction Specification for a CABI

CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management
Project Specific Construction Specification

Bid Item: **01-21.19.01 Certified Asbestos Building Inspector (CABI)/Air Monitor (Hourly)**

38th & Holly Detention Pond Improvements

ALLOWANCE ACCOUNT ITEMS

DESCRIPTION

This Special Provision contains the City and County of Denver's estimate for Allowance Account Items for ***all allowances*** necessary for the ***hourly Certified Asbestos Building Inspector/Air Monitor***. Duties of the CABI/Air monitor shall be to provide asbestos awareness training for all personnel associated with the project; monitor and cause to enforce that all project activities, excavations and site controls are in compliance with Denver Department of Public Health and Environment – Asbestos-Contaminated Soil Management Standard Operating Procedure (current version); ensure compliance with all state and federal laws, regulations and guidelines; and any other duties as defined within a site specific Material Management Plan. The estimated amounts will be added to the total bid to determine the amount of the performance and payment bonds. Allowance Account work shall be performed and reimbursed to the contractor as approved by the City Construction Project Manager. In no event shall reimbursement to the contractor exceed that maximum total indicated in the basis of payment below.

BASIS OF PAYMENT

Payment will be made at unit prices for a schedule of values that are associated with each allowance account item category indicated below (A-D). The hourly employment costs of the CABI/Air Monitor for training; the unit prices for rental costs of any required equipment; coordinating testing and/or disposal of samples as indicated below (A-D). The schedule of values shall be submitted by the contractor and accepted by the City Construction Project Manager within 60 days of Notice to Apparent Low Bidder. CABI shall be a subcontractor and the unit prices will only be paid at true and verifiable cost plus a 3% mark up in accordance with the City and County of Denver General Contract Conditions. Mark up shall not be applied to sales tax or reclamation fees/charges. Payment will constitute full compensation for all true and verifiable costs associated with CABI/Air Monitor and allowances necessary to complete the scope of the project. The contractor will be required to submit itemized invoices for hourly employment of CABI/Air Monitor, rental of equipment for air sampling, testing and/or disposal of samples; along with

a spreadsheet tabulation indicating the 3% for inclusion in the Field Measurement Report (FMR). The City Construction Project Manager will approve payments in the appropriate dollar amount on the monthly payment applications.

No payment will be made under this bid item for any items associated with bid item 3-2 **Hauling of Contaminated Materials to Denver/Arapahoe Disposal Site (DADS).**
Allowance Account work must be coordinated through an approved* Environmental Consulting Firm with access to a Certified Asbestos Building Inspector (CABI) who can provide training, perform visual inspection and air monitoring, reporting, collect samples and submit for testing in compliance with all federal, state, and local requirements, and shall only be paid for after receipt of an itemized statement endorsed by the Contractor and approved by the City Construction Project Manager.

Item No.	Allowance Account Item	Quantity	Estimated Amount
01-21.19.01 A	CABI/Air Monitor Hourly	A/A	$25,000.00
01-21.19.01 B	Materials & Equipment	A/A	$10,000.00
01-21.19.01 C	Lab Testing	A/A	$10,000.00
01-21.19.01 D	Disposal of Waste & Associated Profiling	A/A	$5,000.00
		Maximum Total:	**$50,000.00**

Allowance Account Item Definitions:

01-21.26.01A **CABI/Air Monitor Hourly** – The price shall include all the Contractor's costs of whatsoever nature, incurred in contracting with an approved* Environmental Consulting Firm for the services of a CABI/Air Monitor. The price shall include: all labor required for the inspector to provide Asbestos Awareness Training to all job site personnel, respond within 2 hours to evaluate potential asbestos containing material, and collect air fiber samples for evaluation of suspicious materials; monitoring of all construction activities once asbestos is confirmed.

01-21.26.01B **Materials and Equipment** – The price shall include: all materials and equipment required for the inspector to provide training, monitor the construction site, evaluate potential asbestos containing material, and collect air fiber samples.

CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management
Project Specific Construction Specification

01-21.26.01C **Lab Testing & Associated Profiling** – The price shall include: Laboratory testing of any suspect materials, soil samples or air fibers to evaluate for the presence of asbestos; including laboratory analysis costs associated with creation of a disposal profile and any required modification of the site-specific Materials Management plan.

01-21.26.01D **Disposal of Sample Waste** – The price shall include*:* Proper disposal of sample waste or contaminated materials associated with the testing and profiling of the suspect materials to ensure compliance with all federal, state, and local requirements transportation

*Approval of the Environmental Consulting firm shall be in the form of a submittal after contract award.

Date Issued 04-27-2018

Attachment D to Addendum No. 2, 201841403

Proposed Pond Rendering

DETENTION POND IMPROVEMENTS

VIEW 1: Bird’s-eye rendering of drop structure design showing gabion walls, paving pattern, box culvert crossing, forebay, and vegetation.

VIEW 2: Rendering of drop structure design showing box culvert crossing, gabion walls, paving pattern, and trickle channel beyond.

DETENTION POND IMPROVEMENTS
38TH AVE & HOLLY ST.

Public Meeting
April 12, 2018

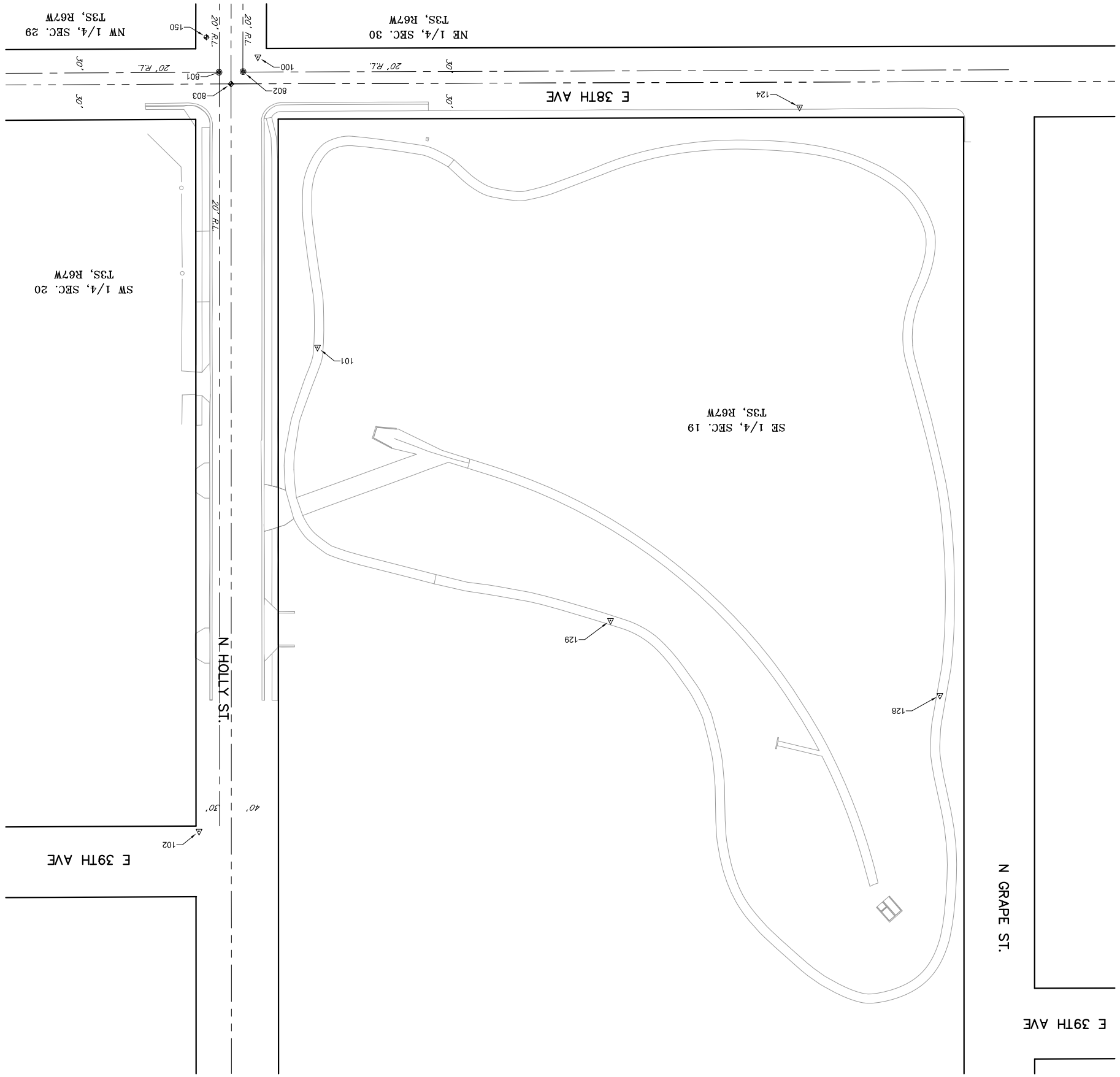
DENVER
THE MILE HIGH CITY

MULLER ENGINEERING COMPANY
stream landscape architecture + planning

Attachment E to Addendum No. 2, 201841403

Sheet 03-Survey Control Diagram which was inadvertently omitted

SURVEY CONTROL DIAGRAM



SCALE: 1" = 50'

0 50' 100'

N

Point Table

Point #	Northing	Easting	Elevation	Row Description
100	405064.34	593162.80	5271.11	TVP100 SET CUT X
101	405310.81	593112.15	5269.69	TVP101 SET CUT X
102	405721.79	593212.74	5271.54	TVP102 SET CUT X
124	405106.82	592702.89	5273.82	TVP124 SET CUT X
128	405606.42	592583.74	5269.33	TVP128 SET CUT X
129	405542.78	592863.36	5264.37	TVP129 SET CUT X
150	405047.49	593206.40	5271.38	BENCH MARK 266A
801	405077.30	593195.64	0	RANGE POINT
802	405076.74	593175.25	0	RANGE POINT
803	405087.21	593185.42	0	LAND CORNER

NOTE

ALL RANGE POINTS OR OTHER SURVEY MOUUMENTS WHICH MAY BE DESTROYED DURING CONSTRUCTION SHALL BE TIED OUT AND RESET BY THE CONTRACTOR'S SURVEYOR. THIS WORK CONSISTS OF LOCATING, PRESERVING, REFERENCING, INSTALLING AND RESTORING LAND MOUUMENTS, SUCH AS PRIMARY CONTROL MOUUMENTS FROM WHICH THE RIGHT OF WAY OR ANY LAND BOUUNDARY WILL BE CALCULATED, DESCRIBED OR MOUUMENTED, PUBLIC LAND SURVEY SYSTEM (PLSS) MOUUMENTS, GENERAL LAND OFFICE (GLO) MOUUMENTS, BUREAU OF LAND MANAGEMENT (BLM) MOUUMENTS, RIGHT OF WAY (ROW) MOUUMENTS, PROPERTY BOUUNDARY MOUUMENTS AND OFFSETS, RANGE POINTS, BENCHMARKS, EASEMENT MOUUMENTS, AND OTHER MOUUMENTS THAT ARE REQUIRED BY LAW OR REGULATION TO BE ESTABLISHED AND RECORDED BY A PROFESSIONAL LAND SURVEYOR (PLS), ALONG WITH INSTALLING OR ADJUSTING MOUUMENT BOXES.

THE PRODUCTION OF ADDITIONAL DOCUMENTATION MAY BE REQUIRED BY THE CITY SURVEYORS OFFICE. ALL SUCH WORK INCLUDED IN THIS SECTION SHALL BE UNDER THE SUPERVISION OF A PLS WHO IS LICENSED IN THE STATE OF COLORADO.

BENCHMARK

CCD BM 371, A BRASS CAP AT THE SE CORNER OF HOLLY ST. AND 38TH AVE., ELEVATION 5271.38'.

PROJECT MAPPING PROJECTION:

TRANSVERSE MERCATOR ZONE: CCD_LOCAL
DATUM: NAD83-1992
CENTRAL POINT FALSE NORTHING = 4000000.0000
CENTRAL POINT FALSE EASTING = 6000000.0000
LATITUDE OF ORIGIN = N39°43'19.00000"
CENTRAL MERIDIAN = W104°53'53.00000"
ZONE WIDTH = 6°0'00.0"
SCALE FACTOR AT ORIGIN = 1.000254030000
UNITS ARE US SURVEY FEET.

LEGEND:

+	SURVEY MONUMENT (SEE POINT LIST)
+	CHISELED "+"
▲	CHISELED "X"
	LAND LINE
	RANGE LINE
	R.O.W. LINE
	IMPROVEMENTS

>>PROJECT NAME<<

LAND SURVEY CONTROL DIAGRAM

DESIGNED BY: XXX
APPROVED BY: XXX
CONTRACT NUMBER: XXXXXX
DENVER PCO NUMBER: 2011-XXXX-XX
DATE: 10/10/2017
SHEET NO.: 1 of 1

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG
TWO-CALL 811
UTILITY NOTIFICATION CENTER OF COLORADO

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
CITY SURVEYOR'S OFFICE
201 WEST COLFAX AVE. DENVER, CO 80202

Attachment F to Addendum No. 2, 201841403

Sheets 34-38 which were inadvertently labeled as “not for construction” in the bid set

Irrigation Equipment and Materials Schedule

SYMBOL	MANUFACTURER	MODEL NO.	DESCRIPTION	DETAIL NO.	COMMENTS
● x	RAIN BIRD	RD-12-S-P30-F W/ MPR NOZZ.	POP-UP SPRAY HEAD	1	
● 1	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP-Corner NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● M	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP1000-360 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● O	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP2000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● Bk	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP2000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● R	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP2000-360 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● B	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP3000-360 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● Lb	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP1000-210 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● Lb	RAIN BIRD	RD-12-S-P45-F W/ HUNTER MP3500-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
● 2.5LA	HUNTER	I-20-12 W/ #2.5LA NOZZLE	GEAR DRIVEN ROTOR	2	
● 3.0	HUNTER	I-20-12 W/ #3.0 NOZZLE	GEAR DRIVEN ROTOR	2	
● 4.0	HUNTER	I-20-12 W/ #4.0 NOZZLE	GEAR DRIVEN ROTOR	2	
(R)	HUNTER	WRC	RAIN SENSOR	8	
⊙	NETAFIM	LHM15TG1PREHR-NO	PRESSURE REDUCING HYDROMETER	12	NORMALLY OPEN REED SWITCH PRESSURE REDUCING
———		CLASS 200 SOLVENT WELD - 1" DIA. UNLESS NOTED OTHERWISE	PVC LATERAL	11	
— · —		CLASS 200 SOLVENT WELD	PVC MAINLINE	11 & 15	SEE NOTE BELOW
═══		CLASS 200 SOLVENT WELD	PVC SLEEVING	7	
⬬		LINE SIZE	GATE VALVE	6	
◥	FEBCO	1-1/2" DIA.	BACKFLOW PREVENTER	12 & 13	
(M)		EXISTING - 1-1/2"	WATER METER	-	
◇	TORO	SB-BLA	TWO-WIRE SURGE ARRESTOR	10	
♦	MUELLER CO.	#300 - 1" DIA.	MANUAL DRAIN VALVE	5	
▼	BUCKNER-SUPERIOR	QB44LRCAR10	QUICK COUPLING VALVE	4	
◓	RAIN BIRD	PEB SERIES	ELECTRIC CONTROL VALVE	3	
⬡	TORO	SBTW204-U2/AC-SB18SS/PC/DG-VRA-FK-GFI	ELECTRIC CONTROLLER	9	

CONTROLLER & STATION NO.
CONTROL VALVE SIZE

MAINLINE TO BE SOLVENT WELD PVC. ALL MAINLINE FITTINGS AND SERVICE/LATERAL TEES TO BE LEEMCO GASKETED, DUCTILE IRON WITH PIPE-TO-FITING MECHANICAL RESTRAINTS.

CONTROLLER LOCATION "A"

PEDESTAL MOUNT TORO SENTIENEL SERIES 204 STATION TWO-WIRE CONTROLLER AT INDICATED LOCATION (RE: EQUIPMENT SCHEDULE FOR MODEL NUMBER). 120 VOLT ELECTRICAL POWER IS AVAILABLE AT ADJACENT OVERHEAD ELECTRIC POLE. ELECTRICAL POWER AND CONNECTION TO CONTROLLER IS BY CONTRACTOR WITH WORK CONFORMING TO LOCAL CODE. FEES AND PERMITS ASSOCIATED WITH WORK ARE TO BE OBTAINED AND PAID BY CONTRACTOR. FINAL LOCATION OF CONTROLLER SHALL BE REVIEWED AND APPROVED BY OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION.

REFER TO ENLARGEMENT - SHEET 34

PT. OF CONNECT. - 1-1/2"

REMOVE EXISTING CONTROLLER, WIRE SPLICE BOX, BACKFLOW ENCLOSURE, CONCRETE PAD AND DOWNSTREAM COPPER RISER AT INDICATED LOCATION. RETURN ENCLOSURE AND CONTROLLER TO DP&R. DISPOSE OF OTHER MATERIALS AT OFF-SIRE LOCATION. TIE ONTO EXISTING UPSTREAM 1-1/2" COPPER RISER. INSTALL 1-2" REDUCED PRESSURE BACKFLOW PREVENTER, 1-1/2" HYDROMETER, 1" MANUAL DRAIN VALVE, QUICK COUPLING VALVE (W/ 100% ALL BRASS SWING JOINT) AND EXTEND CLASS 200 PVC MAINLINE AS SHOWN. EXTEND ONE RUN PAIGE ELECTRIC P7171D-A FLOW SENSOR CABLE FROM HYDROMETER TO CONTROLLER "A". CONNECT CABLE TO HYDROMETER PER MANUFACTURER'S RECOMMENDATIONS. CONNECT TWO-WIRE CABLE WITH DECODER TO VALVE SOLENOID.

INSTALL SLEEVE UNDER WALK VIA MECH. BORING OR PNEUMATIC "MISSILE"

EXISTING LANDSCAPE TO REMAIN

EXISTING LANDSCAPE

EXISTING LANDSCAPE

PARK HILL FAMILY PRACTICE CTR. (DENVER HEALTH) 3900 GRAPE ST.

1-STORY MODULAR BUILDING

GAS METER

GRAPE ST.

HOLLY

72"STM

21"SAN

18"SAN

10"SAN

8"SAN

8"W

10"W

4"G

2"G

1-1/2"

2"

0 40' 80'

SCALE: 1" = 40'

PLOT DATE: May 17, 2018
C:\~DWG\38TH AND HOLLY DETENTION POND\IRRIGATION 2-2-18.DWG

Avocet
IRRIGATION DESIGN
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LAKEWOOD, COLORADO 80235
VOICE: 303.986.2175
FAX: 303.989.5814

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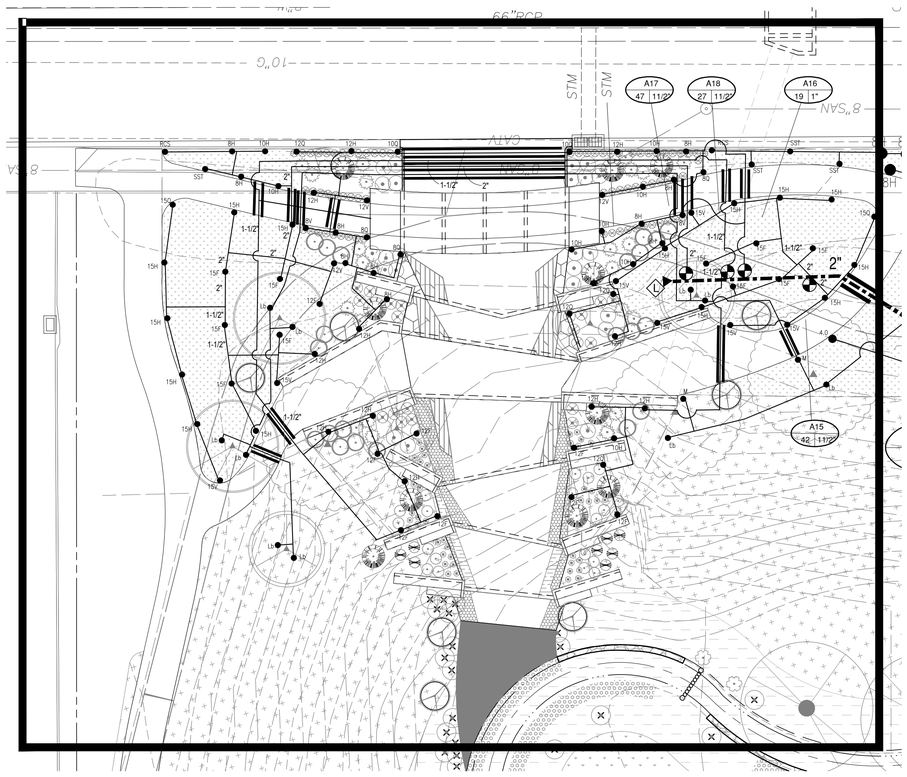
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

38TH & HOLLY
DETENTION POND IMPROVEMENTS

PRO TRACKING NO: PWW2017-007
PROJECT MASTER NO: 2017 - PROJMSTR-0000463
DROP STRUCTURE CONCRETE PAVEMENT

DRAWN BY:	DZ
DESIGNED BY:	DZ
APPROVED BY:	DZ
DRAWING NAME:	IRRIGATION PLAN
DATE:	02/07/18
SHEET NO.:	34 OF 38

Avocet
IRRIGATION DESIGN
7114 W. JEFFERSON AVENUE, SUITE 201
LAKEWOOD, COLORADO 80235
VOICE: 303.986.2175
FAX: 303.989.5814



ENLARGEMENT - IRRIGATION PLAN

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38TH & HOLLY
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PRO TRACKING NO: PWW2017-007
PROJECT MASTER NO: 2017 - PROJMSTR-0000463

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DRAWN BY: DZ
DESIGNED BY: DZ
APPROVED BY: DZ
DRAWING NAME: IRRIGATION PLAN
DATE: 02/07/18
SHEET NO.: 35 OF 38

0 20' 40'
SCALE: 1" = 20'

PLOT DATE: May 17, 2018
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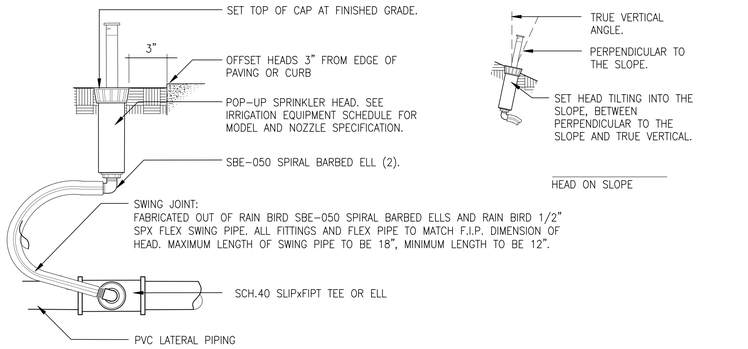
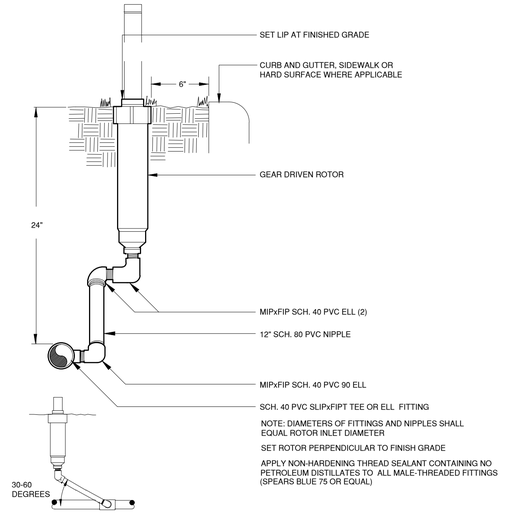


NOTE:
1. PLUMB HEAD PERPENDICULAR TO FINISHED GRADE OR AS SPECIFIED FOR HEADS ON A SLOPE.
2. SET TOP OF HEAD LEVEL WITH FINISHED GRADE IN TURF GRASS AREAS. SET TOP OF HEAD 1/2" ABOVE FINISHED GRADE IN SEEDED AREAS.
3. LATERAL PIPE TO BE PLACED 9" MIN FROM EDGE OF CURB/WALKS AND 36" MIN FROM THE CENTERLINE OF SWALES.
4. SWING PIPE SHALL BE CONNECTED TO BOTTOM INLETS OF HEADS. DO NOT USE SIDE INLETS.

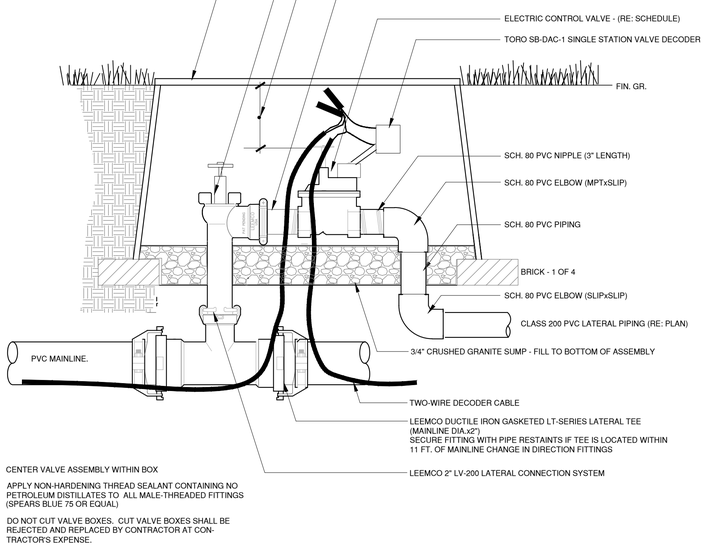
POP-UP HEAD

1



HI-POP GEAR DRIVEN ROTOR

2



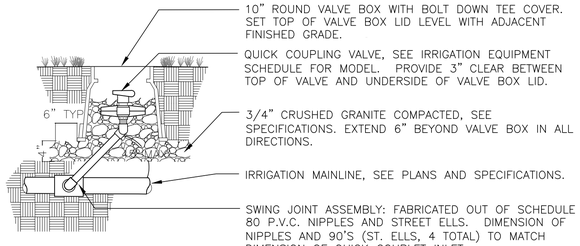
CENTER VALVE ASSEMBLY WITHIN BOX

APPLY NON-HARDENING THREAD SEALANT CONTAINING NO PETROLEUM DISTILLATES TO ALL MALE-THREADED FITTINGS (SPEARS BLUE 75 OR EQUAL)

DO NOT CUT VALVE BOXES. CUT VALVE BOXES SHALL BE REJECTED AND REPLACED BY CONTRACTOR AT CONTRACTOR'S EXPENSE.

ELECTRIC CONTROL VALVE

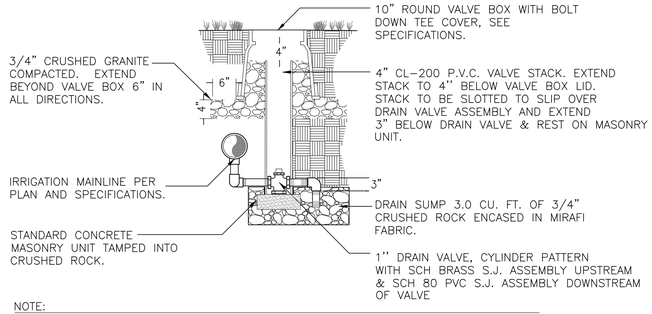
3



NOTE:
1. INSURE THAT HANDLE ON QUICK COUPLER KEY WILL CLEAR VALVE BOX IN ALL DIRECTIONS.
2. BRAND (QC) INTO VALVE BOX LID WITH 1" HIGH LETTERS MIN.
3. NIPPLE ANGLE TO BE 10 DEGREES MIN. AND 45 DEGREES MAX. INSTALL SWING JOINT SUCH THAT DOWNWARD PRESSURE ON VALVE WILL TIGHTEN FITTING INTO MAINLINE TEE.
4. FOR QUICK COUPLERS LOCATED WITHIN 100 FEET OF BACKFLOW PREVENTION DEVICES AND INTENDED FOR WINTERIZATION USE, ALL FITTINGS AND NIPPLES OF THE SWING JOINT ASSEMBLY MUST BE CONSTRUCTED ENTIRELY OF BRASS.

QUICK COUPLING VALVE

4



NOTE:
1. BRAND (DV) INTO VALVE BOX LID WITH 1" HIGH LETTERS MIN.
2. EXTEND VERTICAL DISCHARGE NIPPLE INTO DRAIN SUMP A MINIMUM OF 3".
3. SET TOP OF VALVE BOX LID LEVEL WITH FINISHED GRADE OF ADJACENT TURFGRASS AREAS.

MANUAL DRAIN VALVE

5

Irrigation Construction Notes

1. ALL BASE INFORMATION HAS BEEN TAKEN FROM DRAWINGS PREPARED BY STREAM DESIGN.
2. REFER TO TECHNICAL SPECIFICATIONS AND CONSTRUCTION DETAILS FOR INSTALLATION PROCEDURES.
3. CONTRACTOR SHALL FIELD VERIFY PRESSURE AT BACKFLOW PREVENTER LOCATION FOR EACH TAP PRIOR TO ORDERING MATERIALS OR STARTING ANY IRRIGATION INSTALLATION AND NOTIFY CONSULTANT OF ANY DIFFERENCES FROM STATED PRESSURE. IF CONTRACTOR FAILS TO NOTIFY CONSULTANT HE ASSUMES FULL RESPONSIBILITY FOR ANY SYSTEM ALTERATIONS. EACH SYSTEM HAS BEEN DESIGNED FOR A STATIC PRESSURE OF 105-115 PSI (PER DENVER WATER).

P.O.C. NUMBER	REQUIRED PRESSURE
1	78 PSI

4. CONTRACTOR SHALL COORDINATE INSTALLATION OF SLEEVING WITH INSTALLATION OF CONCRETE FLATWORK AND PAVING. ALL SLEEVING IS BY CONTRACTOR UNLESS OTHERWISE NOTED. UNLESS NOTED OTHERWISE ON IRRIGATION PLANS INSTALL SLEEVING BASED ON SLEEVE SIZING GUIDE BELOW:

PIPE SIZE OR WIRE QUANTITY	REQUIRED SLEEVE
1" PIPING	1-2" PVC SLEEVE
1-1/2" - 2" PIPING	1-4" PVC SLEEVE
2-1/2" - 3" PIPING	1-6" PVC SLEEVE
TWO-WIRE CABLE	1-2" PVC SLEEVE

NOTE: EACH LENGTH OF SLEEVED PIPE SHOWN SHALL BE ROUTED THROUGH SEPARATE SLEEVE. IRRIGATION WIRE BUNDLE SHALL BE ROUTED IN SEPARATE SLEEVE/CONDUIT WITHOUT IRRIGATION PIPING

5. WHERE NOT NOTED ON IRRIGATION PLANS CONTRACTOR TO INSTALL PLASTIC 15 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED GREATER THAN 12 FEET. INSTALL 12 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED 10-12 FEET. INSTALL 10 SERIES NOZZLES NOZZLES ON ALL POP-UP SPRAY HEADS SPACED 8-10 FEET. INSTALL 8 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED 8 FEET AND LESS.
6. REFER TO PLANTING PLAN FOR EXACT TREE LOCATIONS AND QUANTITIES, TREES SHOWN ON IRRIGATION PLANS ARE APPROXIMATE.
7. CONTRACTOR SHALL REPAIR OF REPLACE ANY EXISTING IRRIGATION EQUIPMENT, TURF, PLANT MATERIAL OR SITE FEATURES DAMAGED DURING NEW INSTALLATION. REPLACEMENT OR REPAIR OF DAMAGED EQUIPMENT OR MATERIAL SHALL BE DETERMINED BY THE OWNER AND THE CONSULTANT.
8. VALVE BOXES SHALL BE LOCATED 36" MINIMUM FROM CENTERLINE OF ALL SWALES, 24" MINIMUM FROM EDGES OF ALL WALKS, CURBS, DRIVES AND OTHER HARD SURFACE AREAS.
9. REFER TO IRRIGATION TECHNICAL SPECIFICATIONS FOR PLANTING AND IRRIGATION LAY-OUT REQUIREMENTS, COORDINATION AND PRIORITIES.
10. LATERAL PIPING DIAMETERS SHALL INCLUDE 1", 1 1/2" AND 2". 3/4" AND 1 1/4" DIAMETER LATERAL PIPE IS NOT ACCEPTABLE.

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TEL.: (303) 446-3617 FAX: (303) 446-3647

38TH & HOLLY
DETENTION POND IMPROVEMENTS
PRO TRACKING NO: PWW2017-007
PROJECT MASTER NO: 2017 - PROJMSTR-0000463
DROP STRUCTURE CONCRETE PAVEMENT

DRAWN BY:	DZ
DESIGNED BY:	DZ
APPROVED BY:	DZ
DRAWING NAME:	IRRIGATION DETAILS
DATE:	02/07/18
SHEET NO.:	36 OF 38

PLOT DATE: May 17, 2018
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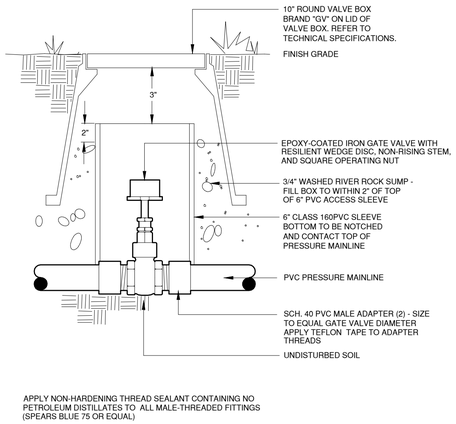
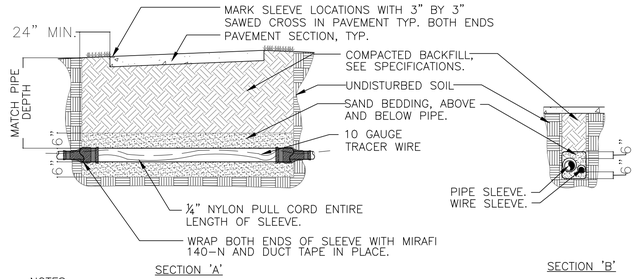


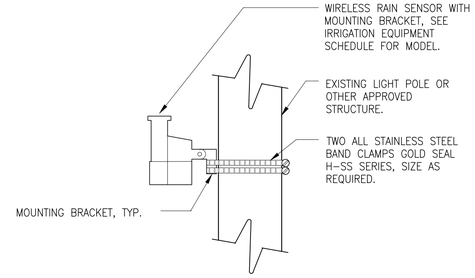
APPLY NON-HARDENING THREAD SEALANT CONTAINING NO PETROLEUM DISTILLATES TO ALL MALE-THREADED FITTINGS (SPEARS BLUE 75 OR EQUAL)

GATE VALVE 6



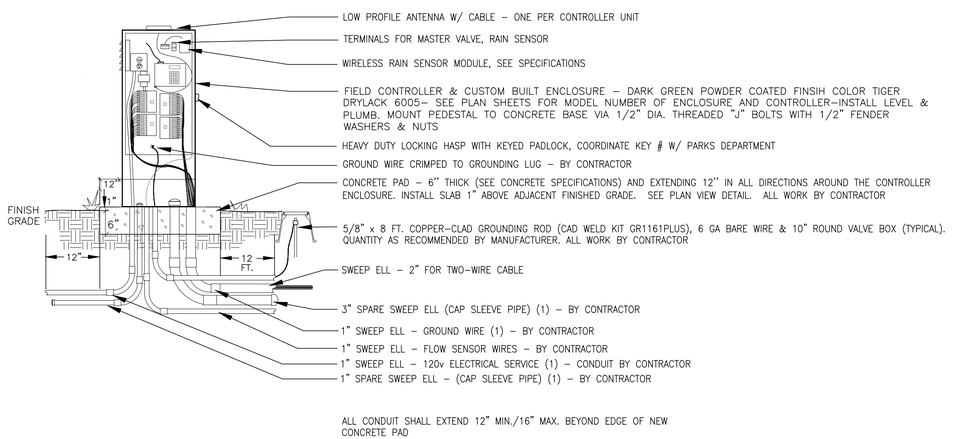
NOTES:
1. SLEEVING SHALL BE CL-200 P.V.C. UNLESS OTHERWISE NOTED ON PLAN.
2. ALL MAINLINE SLEEVES HAVE A SEPARATE COMPANION SLEEVE FOR WIRE, PLACED SIDE BY SIDE.
3. MULTIPLE SLEEVES INSTALLED ADJACENT TO ONE ANOTHER ARE TO BE PLACED SIDE BY SIDE, NEVER STACKED.
4. ALL MAINLINE AND LATERAL SLEEVES SHALL BE A MINIMUM OF 2 PIPE SIZES LARGER THAN THE PIPE BEING SLEEVED.
5. BACKFILL ANY RELATED SLEEVING EXCAVATIONS AND MECHANICALLY AND COMPACT IN 6" MAX. LIFTS TO 95% BY VIBRATORY COMPACTION METHOD UNDER ALL PAVEMENT SECTIONS.
7. SLEEVES SHALL BE INSTALLED AT SAME DEPTH AS MAINLINE OR LATERALS. SLEEVES TO BE INSTALLED AT 24" DEPTH MINIMUM UNDER ROADWAYS.
8. WATER SETTLING OF TRENCHES UNDER PAVEMENT IS NOT PERMITTED.

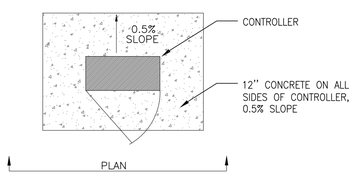
SLEEVING 7



NOTE:
1. MOUNT TO POLE OR LIGHT POLE WITHIN 200 FEET OF CONTROLLER.
2. INSTALL A MINIMUM OF 15' ABOVE GRADE.
3. ENSURE SENSOR IS NOT SHIELDED BY TREE CANOPIES OR STRUCTURES AND NOT AFFECTED BY IRRIGATION OVERSPRAY.

RAIN SENSOR 8

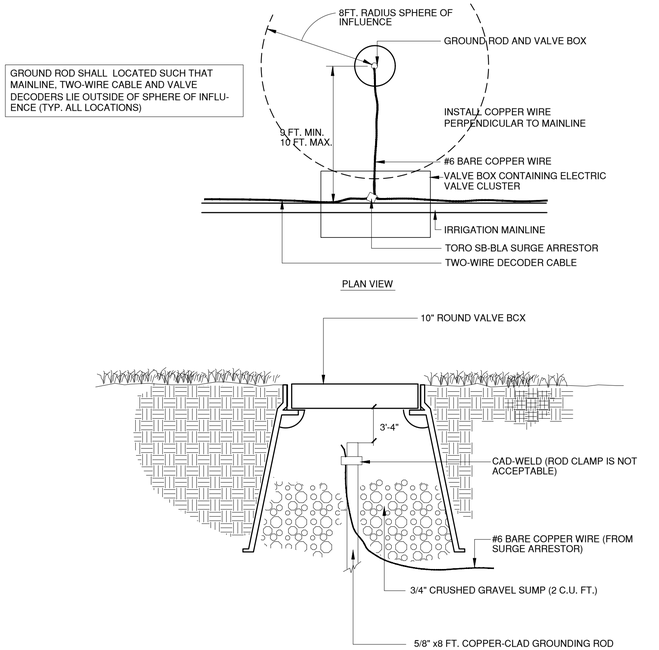




GENERAL NOTES AND REQUIRMENTS
1. 450 MHz RADIO COMMUNICATION SYSTEM SHALL BE FULLY COMPATIBLE WITH EXISTING DENVER DEPARTMENT OF PARKS AND RECREATION CENTRAL CONTROL UNIT RADIO FREQUENCY.
2. FLOW SENSOR SHIELDED CABLE (PAIGE 7171D-A) SHALL BE CONNECTED TO FLOW SENSOR TERMINAL AT TOP OF CONTROLLER.
3. MASTER VALVE WIRE SHALL BE CONNECTED TO THE TORO ESB-CAB-NET WIRE HARNESS LOCATED AT TOP OF CONTROLLER BASE UNIT
4. ALL WIRE CONDUITS SHALL BE SCH. 40 PVC CONDUIT AND SHALL EXTEND A MINIMUM OF 12" BEYOND THE CONCRETE SLAB AND CUT FLUSH WITH CONCRETE PAD.
5. CONTRACTOR SHALL PROVIDE 48" LENGTH OF SPARE CABLE WITHIN ENCLOSURE. NEATLY COIL CABLE AT BASE OF ENCLOSURE. BUNDLE AND LABEL WIRES ACCORDING TO CONTROLLER DESIGNATION SHOWN ON PLANS.
6. LOCATE CONTROLLER ENCLOSURE SO THAT IRRIGATION HEADS DO NOT SPRAY INTO CABINET.
7. CONTRACTOR SHALL ARRANGE AND PAY FOR A SITE SURVEY FOR ANTENNA SET-UP FOR MAXIMUM SIGNAL QUALITY FOR EACH CONTROLLER SITE AND OPTIMIZATION OF CENTRAL CONTROL COMMUNICATION AFTER INSTALLATION. CONTACT BRANDON GULLY AT CPS (303) 961-6959). SURVEY TO BE CONDUCTED PRIOR TO CONSTRUCTION AND ORDERING OF EQUIPMENT AND IN SUMMER TIME DURING FULL TREE LEAF OUT.

ELECTRICAL AND GROUNDING NOTES:
1. CONTRACTOR TO GROUND AND PROVIDE SURGE PROTECTION FOR FIELD UNIT IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND GROUND ROD(S) SHOWN. 6 GA. (MIN) BARE COPPER GROUND WIRE SHALL BE CONNECTED AND CRIMPED TO STUDS ON THE BACKSIDE OF THE PANEL.
2. CONTROLLER(S) SHALL BE EARTH GROUND TESTED VIA MEGGER WITH ACCEPTABLE GROUND RESISTANCE OF 10 OHMS OR LESS. CONTRACTOR SHALL PERFORM GROUNDING TEST IN PRESENCE OF DENVER PARKS & RECREATION REPRESENTATIVE OR CONSULTANT.
3. EARTH GROUND MUST BE IN ACCORDANCE WITH ARTICLE 250 OF THE NATIONAL ELECTRICAL CODE (NEC).
4. ALL ELECTRICAL WORK TO CONFORM TO LOCAL AND STATE CODES.

CONTROLLER 9



TWO-WIRE SURGE ARRESTOR 10

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38TH & HOLLY
DETENTION POND IMPROVEMENTS
PRO TRACKING NO: PWW2017-007
PROJECT MASTER NO: 2017 - PROJMSTR-0000463
DROP STRUCTURE CONCRETE PAVEMENT

DRAWN BY: DZ
DESIGNED BY: DZ
APPROVED BY: DZ
DRAWING NAME: IRRIGATION DETAILS
DATE: 02/07/18
SHEET NO.: 37 OF 38

PLOT DATE: May 17, 2018
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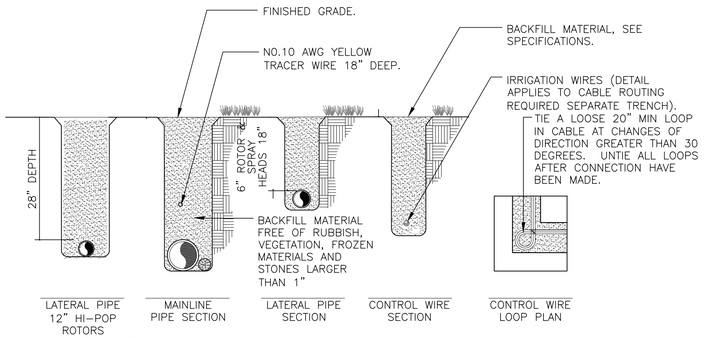
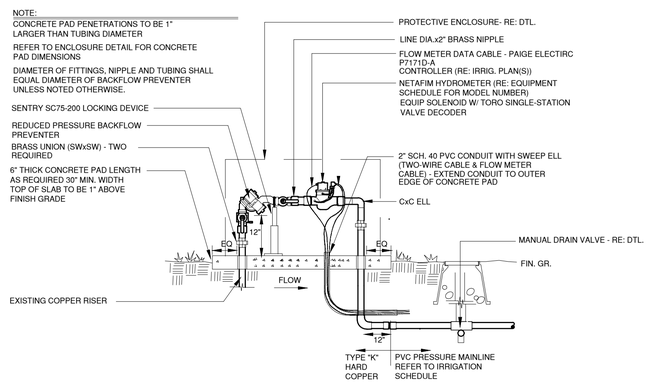


NOTE:
1. TRENCH DEPTHS ARE SHOWN AS MINIMUMS, MAXIMUM DEPTH VARIATION ALLOWABLE IS 2". SEE SPECIFICATIONS FOR MINIMUM TRENCH WIDTHS.
2. MULTIPLE IRRIGATION PIPES SHALL NOT BE INSTALLED IN THE SAME TRENCH.
3. SEE SPECIFICATIONS FOR TYPICAL BACKFILL MATERIAL, PROCEDURES AND REGULATIONS.

TRENCHES

11

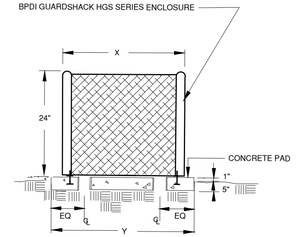


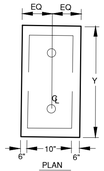
BACKFLOW PREVENTER/HYDROMETER

12

NOTES
PAD PENETRATIONS FOR BACKFLOW PREVENTER RISERS TO BE 1" LARGER THAN RISER DIAMETER
TOP SURFACE OF CONCRETE PAD SHALL BE 1" ABOVE FINISH GRADE.

ENCLOSURE MODEL	X	Y
HGS-3	40"	52"

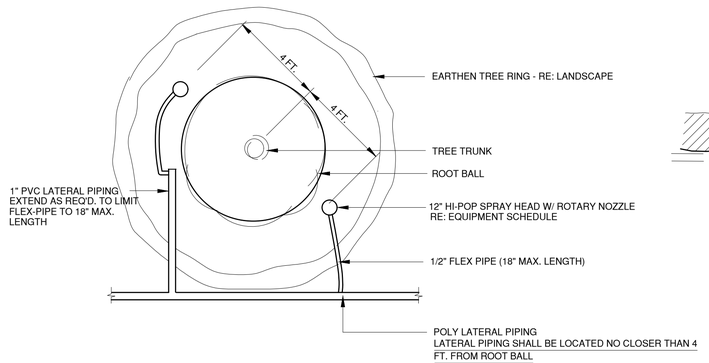


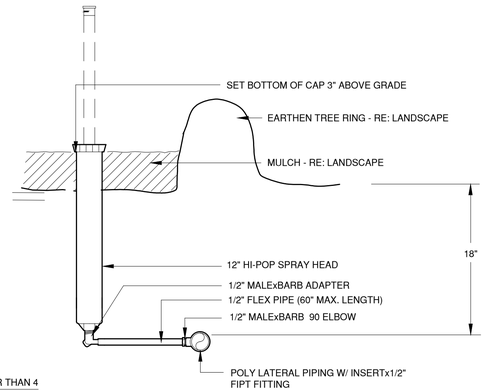


INSTALL ENCLOSURE ANCHORS AS PER MANUFACTURER'S RECOMMENDATIONS.
PROVIDE OWNER WITH KEYED PADLOCK FOR ENCLOSURE
PROVIDE ENCLOSURE IN FEDERAL GREEN COLOR
ENCLOSURE SHALL BE INSTALLED W/ GUARDSHACK ES SERIES ENCLOSURE SETTER

BACKFLOW ENCLOSURE

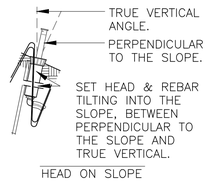
13





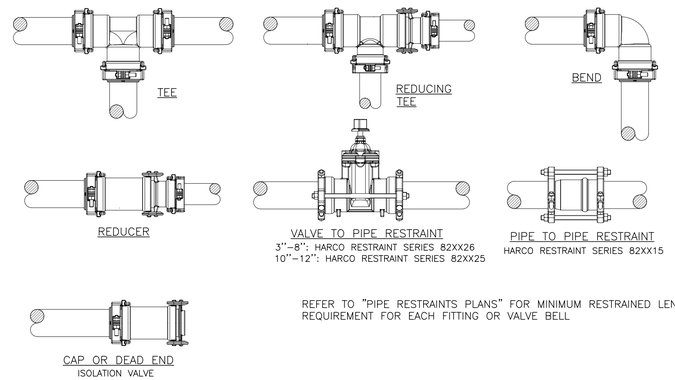
SIDE INLET IS NOT TO BE UTILIZED FOR SWING JOINT CONNECTION

APPLY NON-HARDENING THREAD SEALANT CONTAINING NO PETROLEUM DISTILLATES TO ALL MALE-THREADED FITTINGS (SPEARS BLUE 75 OR EQUAL)



HI-POP SPRAY HEADS - TREES IN NATIVE SEEDED AREAS

14



REFER TO "PIPE RESTRAINTS PLANS" FOR MINIMUM RESTRAINED LENGTH REQUIREMENT FOR EACH FITTING OR VALVE BELL

NOTES:
1. THE RESTRAINT SCHEMES HERE ARE FOR SYSTEM PRESSURES UP TO 125 PSI. FOR HIGHER PRESSURES, CALL THE HARCO FACTORY.
2. EACH FITTING AND VALVE BELL MUST BE RESTRAINED TO THE LENGTH OF PIPE NOTED ON PLANS USING FITTING TO PIPE RESTRAINT, VALVE TO PIPE RESTRAINT, AND PIPE TO PIPE RESTRAINT AS REQUIRED.
3. PIPE JOINTS WITHIN THE RESTRAINED LENGTH REQUIREMENT MUST BE RESTRAINED WITH PIPE TO PIPE RESTRAINTS.
4. SERVICE TEES AND COUPLINGS WITHIN THE RESTRAINED LENGTH REQUIREMENT MUST BE RESTRAINED WITH FITTING TO PIPE RESTRAINTS.
5. FITTING BELLS 4" AND BELOW: HARCO RESTRAINTS SERIES 60-100-XX OR 82XX10.

MAINLINE PIPE RESTRAINTS

15

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DRAWN BY:	DZ
DESIGNED BY:	DZ
APPROVED BY:	DZ
DRAWING NAME:	IRRIGATION DETAILS
DATE:	02/07/18
SHEET NO.:	38 OF 38

PLOT DATE: May 17, 2018
C:\~DWG\38TH AND HOLLY DETENTION POND\IRRIGATION 2-2-18.DWG

Attachment G to Addendum No. 2, 201841403

Final Drainage Memo and Design Calculations

Final Drainage Memo and Design Calculations for:

Project: 38th & Holly Detention Pond Improvements
By: Kelly Crum, Sarah Breidt, Sara Trout and Audrey Rogers
Date: 5/2/18

I. **General Location and Project Description**

The existing detention pond is located north of 38th Street between Grape Street and Holly Street. There is an existing concrete rundown on the east side of the pond as well as several pipes which bring stormwater flows into the pond. In addition, there is a pond outfall on the northwest side of the pond which provides detention storage. The area tributary to the pond is 1,301 acres. There are double Type 16 inlets located on Holly Street, towards the north end of the pond, which collect the minor flows and transport them in a 66" RCP. In the existing condition, flows pond up in Holly Street approximately 1.5 feet before overtopping the pond embankment and entering the pond. The existing condition causes severe erosion to the pond embankment during small and large storm events. The purpose of this project is to convey the 5-year event into the pond while minimizing ponding in Holly Street and erosion of the pond embankment. The picture below shows erosion and damage that occurred as a result of a large event in July 2015.

The project also includes the introduction of water quality detention into the pond. This will be achieved with the installation of a new water quality outlet structure which will provide both water

quality and 5-year detention. A diversion from the 66" pipe in Holly will be installed to transport the low flows into the pond. A concrete forebay will be built at the end of this pipe which will collect any sediment or debris before it enters the pond. A natural bottom trickle channel will be installed to transport flows from east to west. In addition, a concrete, gabion and grasscrete drop structure will be installed to collect the larger storm events along Holly Street and transport them safely into the pond, mitigating the erosion due to overtopping.

II. Drainage Design Criteria

A. Master Plan and Previous Studies

The project is located within Basin 4400-02 of the 2014 Denver Storm Drainage Master Plan (Master Plan). EPA SWMM models from Sand Creek (4400-02) and Upper Park Hill (0060-01, 4400-02 & 4500-01) Basins Final Drainage Study prepared by Atkins dated July 2011 were used as a basis for this project also. Please see Appendix A for a copy of the basin map.

B. Drainage Concept

The purpose of this project is to convey the 5-year event into the pond while minimizing ponding in Holly Street and erosion of the pond embankment. The project also includes the introduction of water quality flows into the pond and the addition of water quality capture volume to the pond.

In additional to the spillway overflows previously mentioned, there are two different sources of stormwater to the pond. One of the main stormwater flow inputs to the pond is a 4'x2' box culvert located at the northwest corner. Its original purpose was to take flows from a storm system in Grape Street and transport them into the pond. The system did not function as designed for a number of reasons including the limited capacity in the detention pond and the proximity to the outlet pipe. This system will be disconnected from the pond which will help it function more effectively. The other stormwater source is a 6'x4' box culvert which pulls stormwater off the 66" storm line in Holly Street. This diversion is not located at the invert of the 66" pipe so it is only taking the larger event storms. This pipe will be plugged and a new diversion structure located farther south on Holly will be installed at the correct elevations. This will allow the smaller magnitude storms to enter the pond and allow the pond to provide water quality.

One of the first steps in the design process was to update the hydrologic modeling to reflect the modified condition. With this complete, the pond hydraulics could then be updated. See below for further discussion.

C. Hydrologic Criteria

The Colorado Urban Hydrograph Procedure (CUHP) model from the "Sand Creek and Upper Park Hill Basins Final Drainage Study" (Sand Creek Study) created by Atkins, dated July 2011, was used as a basis for hydrologic modeling. A new version of CUHP (2.0) has recently been released which is showing changes in the magnitude of the storms. The input data from the Sand Creek

Study was inserted into CUHP to obtain updated hydrologic values. Point rainfall values were also updated per Urban Drainage and Flood Control District's (UDFCD's) recommendation to use NOAA Atlas 14 point rainfall values. The new CUHP output is included in Appendix A. A comparison of the flows between the newer version of CUHP and the original flows shows that the newer flows are significantly lower than previous flows. A comparison table of both flows and volumes is included in Appendix A. The results show that there is approximately a 50% decrease in peak flows and almost a 30% decrease in total volumes for each of the contributing catchments.

The Water Quality Capture Volume (WQCV) flows were not modeled as a part of the original Sand Creek Study. However, they were added to the CUHP 2.0 model using a 1-hour WQCV depth of 0.6 inches, as recommended by UDFCD.

D. Hydraulic Criteria

The EPA SWMM model from the Sand Creek Study was used as a basis for hydraulic modeling and was modified to reflect the proposed design. The 4'x2' box culvert that currently enters the pond adjacent to the outlet was removed from the pond. The proposed low flow pipe that will intersect low flows from the 66" RCP near the intersection of 38th and Holly was added to the model, and the pond volume was updated to reflect the proposed grading. The revised CUHP information was used as the hydrology input. Table 1 is a comparison of peak flows to the detention pond. A copy of the SWMM output is located in Appendix B.

Table 1: Comparison of Peak Flow to Pond (Link L2) from SWMM (cfs)

	WQ	2-Year	5-Year
CUHP 1.33- Original SWMM Model	N/A	262	621
CUHP 2.0- Revised SWMM Model	95	147	305

E. Water Quality and Stormwater Detention Criteria

The UD-Detention spreadsheet was used to calculate the total required WQCV per UDFCD criteria for the 1,301-acre basin tributary to the Holly Pond. With this very large tributary area and the limited pond size it was not possible to get the full detention volume. The volume for detention chosen (approx. 5-year storm) was determined in an effort to minimize the backup into the pipes draining into the pond. Per UDFCD criteria, the water quality volume will be detained for 40 hours.

F. Waivers from Criteria

Since this is a retrofit project, the project is unable to provide the required full WQCV.

III. Drainage Facility Design

A. General Concept

The general concept of the project is to convey up to the 5-year flows from Holly Street into the existing pond through two different structures. In the pond, the flows will be conveyed in a trickle channel to a proposed water quality and detention outlet structure. The outlet structure will provide water quality and detention for the 5-year storm.

B. Specific Details

Detention Pond Inflow History

When the pond was originally designed, two flow splitters were installed with the intent to divert flow from the adjacent existing systems. These flow splitters were installed at the existing 48" in 39th Ave at Grape Street and at the existing 66" in Holly Street. They were installed at or above the spring line of the existing system so that low flows would bypass the pond. According to the "38th and Holly Regional Detention Pond and Outfall Pipe Final Drainage Report" prepared by Matrix in November 2006 and revised in March 2007, "Design of the splitters is complicated, and it may take a few years of operation to know the exact elevation to set the weir walls." After six years of operation, it is apparent that the pond is not functioning properly with the flow splitters because the pond is not filling up. Since the 4'x2' concrete box culvert splitter at 39th Avenue and Grape Street enters the pond immediately adjacent to the outfall, the pond does not function correctly hydraulically. Depending on the head in the pond and the head in the 39th Ave system, flows can exit and enter through the 4'x2' box culvert. With more head in the pond, the 48" outfall pipe no longer controls flows exiting the pond because flows also exit the 4' by 2' box culvert, thus the system is not controlled as desired.

Given the issues mentioned, the decision was made to disconnect the 4'x2' box culvert off Holly Street and replace it with a new diversion structure. In addition, the existing diversion which collects flows through the 48" pipe in Grape St. will be abandoned. For both systems, the pipe will be plugged at the upstream end and approximately 12' of pipe will be removed from the downstream end.

Water Quality Capture Volume

As mentioned, UD-Detention was used to size the required WQCV of 22.1 acre-feet. Due to the constraints previously mentioned, it is not possible to get the required volume and still provide 5-year detention. Therefore 4.05 acre-feet can be achieved. This maximum achievable WQCV is controlled by the invert of the existing 66" pipe in Holly Street (5256.55). WQCV will back up into the proposed diversion structure, but only to a maximum depth of 1 foot. This may require some additional maintenance from Denver crews however it was necessary in order to achieve some WQCV. See Appendix C for a copy of the output file.

In the proposed design, a 38"x60" elliptical concrete pipe will carry the diverted flows from the proposed diversion structure to the concrete forebay of the pond. Then an 823 ft long trickle

channel extends from the outlet of the forebay to carry low flows across the pond to the outlet structure. The proposed natural bottom trickle channel width varies between 4' and 10'. It is designed to be 6-inches deep with 3:1 side slopes. Type L soil riprap with a D_{50} = 9 inch will be placed along the outside edge of bends as the channel meanders. This will help keep the low flow channel in its place. For additional vertical stability, boulder check structures will be placed at three locations along the trickle channel to provide consistent channel grades. When maintenance is necessary on the pond, these check structures can be used as a guideline for channel elevations. The outer boulders at the edges of the structure will extend 6-inches above the bench (see construction plans for details.)

The invert at the diversion structure in Holly Street (which will be discussed more later in the report) is a 5256.44. Therefore, the water quality water surface was set at a 5257.50. This corresponds to a storage volume of 4.0 acre-feet. This volume is approximately 18% of the total required WQCV.

Table 2 shows the required vs. actual WQCV provided in the pond.

Table 2: Water Quality Design Summary

	Required	Actual
Tributary Area (acres)	1301	1301
Drain Time (hours)	40	40
Imperviousness	52%	52%
WQCV (acre-feet)	22.1	4.0
WQCV WSEL		5257.50

Diversion Structure

A new diversion structure will be installed on the 66" storm line along Holly Street. The structure will be installed at the invert so that the low flows will be diverted into the pond and treated for water quality. An overflow weir wall will be built in the structure to divert the low flows and convey the larger flows in the pipe. The weir wall is just less than 4' tall and will be made of reinforced concrete. Access manholes and stairs will be provided on both sides of the wall to allow for maintenance access. Due to conflicts with the existing utilities, a 38"x60" elliptical pipe will transport the low flows to the pond. The pipe is running at a flat slope (0.37%) with approximately one foot clear between the bottom of the sanitary sewer and the top of the storm sewer. The elliptical pipe has a capacity of approximately 98 cfs. Similarly, the full capacity of the 66" storm sewer is approximately 237 cfs. Therefore, there will be 139 cfs flowing down the 66" storm sewer through the diversion structure in larger storm events.

At the end of the elliptical pipe will be a concrete lined forebay. The forebay has an arched shape and has a 12" curb around the edge to slow down the water entering the pond. Due to the size of the drainage area it was not possible to size the forebay for the full basin. Also, this is

only one of two locations where flow enters the pond, so only a portion of it actually flows through the forebay. Urban Drainage criteria states that 3% of the WQCV should be stored in the forebay. Based on all of these factors, a required forebay volume was calculated. The necessary volume is 0.038 AF or 1650 CF. Please see the calculation included in Appendix C for additional details.

	Required	Actual
Pond Invert		5253.70
Forebay Depth (inches)	Max. 30	12
Forebay volume- 3% of WQCV (acre-feet)	0.663	0.037

Holly Street Inlet Modifications

In addition to the diversion structure, the inlet on the west side of Holly near the original overflow area will be modified. Currently, the double Type 16 inlet is connected back to the 66" pipe in Holly Street. Under proposed conditions, it will be re-routed west under the new trail concrete box culvert. Although the minimum pipe size as required by the City and County of Denver storm drainage criteria is 18", a diameter of 12" is necessary provide clearance with the CBC. The double Type 16 inlets have a combined capacity of 3.8 cfs during the 5-year storm and before flows will start spilling over the drop structure into the pond. This capacity was determined by using UD-Inlet. See Appendix D for a copy of the output. The 12" pipe extends 70.3 feet from the inlets at a 3.7% slope and daylights on the third drop of the proposed gabion wall drop structure. A flowmaster analysis was completed for the 12" SDR 35 pipe to determine the full-flow capacity. The results show that the pipe can convey 6.8 cfs (Appendix D). Since the inlet capacity is less than the full capacity of the pipe, the 12" pipe will safely pass the required flows.

Gabion Wall Drop

Since the pond is a 5-year detention pond, the drop structure was designed for the maximum peak flow that reaches the drop during the 5-year event. According to the Sand Creek Study, included in Appendix B, the maximum flow in Holly Street is 221 cfs. As mentioned in the previous section, during a 5-year event the existing inlets in Holly Street can capture approximately 3.8 cfs. The proposed 12'' pipe that conveys that flow from the double Type 16 inlet to the third wall of the drop structure can convey 6.8 cfs at full capacity. Therefore, the remaining 214 cfs (221 cfs minus 6.8 cfs) needs to be conveyed to the pond via the gabion wall drop structure.

The broad crested weir equation was used to check the capacity of the concrete box culvert. In this case, a four-cell custom box with a height of 1.9 feet and 4 span sections of 10 feet was used. A 40' long broad crested weir at 1.9 feet depth can convey almost 321 cfs. (Appendix D)

Based on the flow of 214 cfs, the water height will be 1.46' leaving additional capacity in case of clogging. Across the top of the box is the looped trail which runs around the pond.

Six sequential concrete steps constitute the drop structure. One the edges of the drop structure are gabions which act as retaining walls and provide an aesthetic element to the concrete. The concrete drop heights in the middle of the drop range between 1.46 feet and 2.33 feet. Each step is separated by a textured concrete or exposed aggregate platform of varying widths that will dissipate the energy without causing erosion. A low-flow channel will be included below the 12" storm drain from the Holly Street double Type 16 inlet to help convey these minor flows. The low flow will be a smooth concrete surface. A calculation was completed to confirm that the nappe would be contained within each platform as well as on a concrete landing at the base of the structure. The results show that for the 5-year storm the longest length of the drop is 5.78 feet. All of the steps have a platform or landing of at least this distance. Please see the calculations included in Appendix D.

Water Quality Outlet Structure

The entire existing pond outlet structure including headwall and wingwalls will be removed. In addition, the existing 4'x2' box culvert outfall will be plugged at the upstream end and a portion will be removed at the downstream end near the pond. In its place will be a new two-stage structure with an internal micropool per the UDFCD criteria for outlet structures.

A custom structure has been designed which includes orifice plates for both water quality and the 5-year storm. The internal micropool is within the structure. The UD-Detention spreadsheet sized three holes which are to be 3.3"x3.3" square. Instead of using the fine mesh screen in front of the plate, which is prone to clogging, there is a screen closer to the entrance of the structure which will provide removal of the fines. The orifices have deflectors in front of them to minimize passage of larger debris. (See construction plans for additional details)

With the revised hydrology per CUHP 2.0, the flows to the pond were significantly less than the Sand Creek Study model. To maximize the pond volume for detention, the outlet has been reduced from a 48" diameter orifice to a 9" diameter orifice. The maximum pond water surface elevation during the 5-year event, assuming the WQCV is full at the time of the 5-year event, will be 5268.0, and the existing overflow spill elevation is 5268.

The existing pond overflow weir located near the outlet structure will remain in place and the pond will overflow into Grape Street at an elevation of 5268. Future storm drain improvements down 39th Avenue may intercept the pond overflow during major storm events and convey the flow west down 39th Avenue.

IV. **Conclusions**

The 38th and Holly pond hydraulics have been modified to improve the functionality of the pond and add WQCV. These modifications include adding a concrete and gabion wall drop to convey flows into the

pond while minimizing erosion of the pond embankment, replacing the outlet structure to utilize the pond capacity and provide as much water quality as possible, re-grading of the pond to incorporate water quality volume, installation of a diversion structure to intercept the water quality flows from the existing system in Holly Street, abandoning the existing 4'x2' box culvert, and the addition of a forebay, trickle channel and micropool.

V. **References**

1. *38th and Holly Regional Detention Pond and Outfall Pipe Final Drainage Report*. Matrix Design Group, November 1, 2006, revised March 23, 2007.
2. *Sand Creek (4400-02) and Upper Park Hill (0060-01, 4400-02, & 4500-01) Basins Final Drainage Study*. Atkins, July 2011.

Appendices

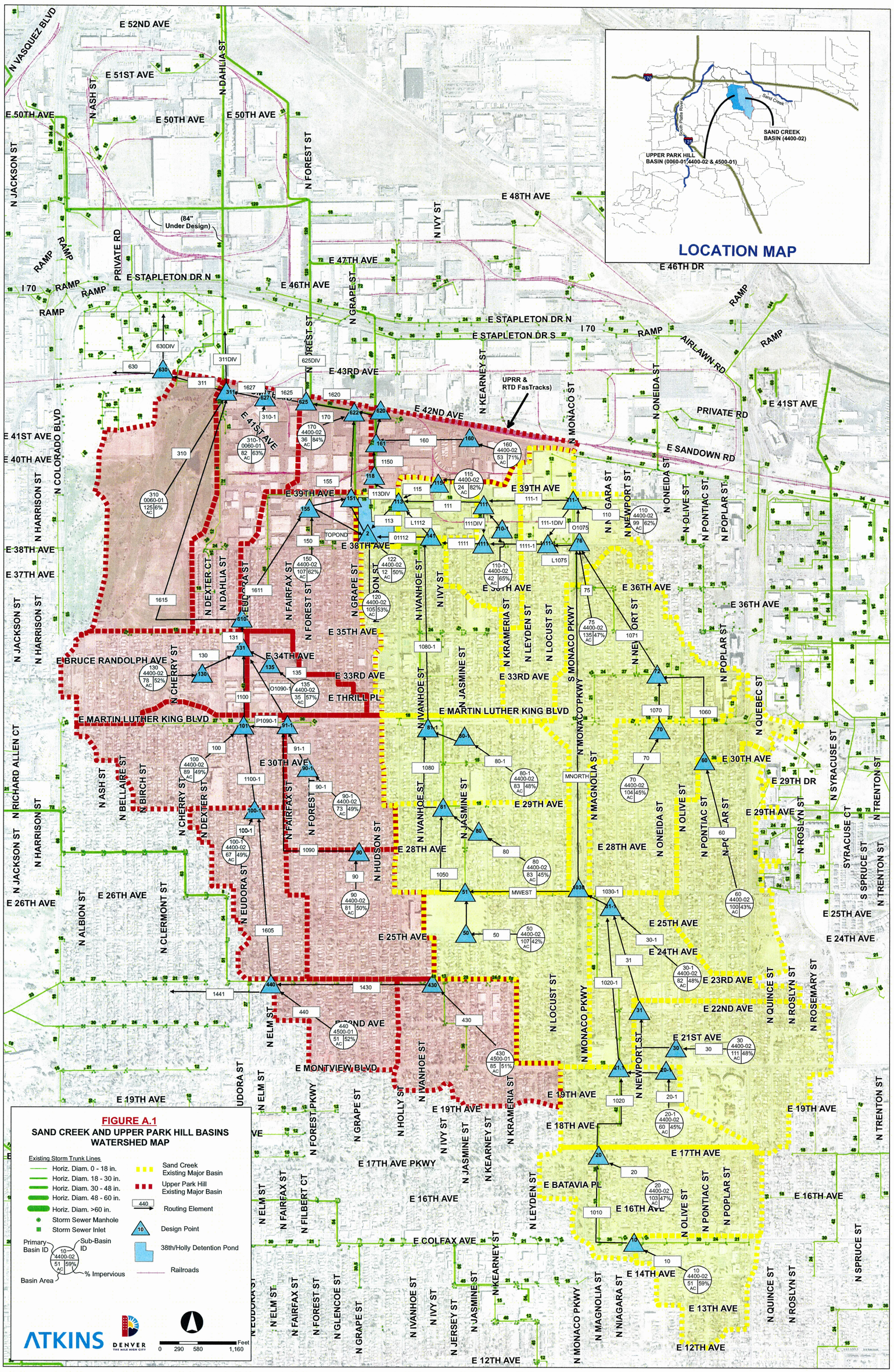
A. Hydrology Calcuations

B. Hydraulic Calculations

C. Detention Pond Calculations

D. Drop Structure Calculations

A. Hydrology Calculations


LOCATION MAP
SAND CREEK BASIN (4400-02)
UPPER PARK HILL BASIN (0060-01, 4400-02 & 4500-01)
Sand Creek
South Platte River
(84" Under Design)
UPRR & RTD FasTracks)
E 52ND AVE
E 51ST AVE
E 50TH AVE
E 48TH AVE
E 47TH AVE
E 46TH AVE
E 46TH DR
E 43RD AVE
E 42ND AVE
E 41ST AVE
E 40TH AVE
E 39TH AVE
E 38TH AVE
E 37TH AVE
E 36TH AVE
E 35TH AVE
E 34TH AVE
E 33RD AVE
E 30TH AVE
E 29TH AVE
E 28TH AVE
E 26TH AVE
E 25TH AVE
E 24TH AVE
E 23RD AVE
E 22ND AVE
E 21ST AVE
E 19TH AVE
E 18TH AVE
E 17TH AVE
E 16TH AVE
E 14TH AVE
E 13TH AVE
E 12TH AVE
E 29TH DR
E STAPLETON DR N
E STAPLETON DR S
E SANDOWN RD
E BRUCE RANDOLPH AVE
E MARTIN LUTHER KING BLVD
E THRILL PL
E MONTVIEW BLVD
E BATAVIA PL
E COLFAX AVE
PRIVATE RD
AIRLAWN RD
I 70
RAMP
N VASQUEZ BLVD
N DAHLIA ST
N ASH ST
N JACKSON ST
N HARRISON ST
N COLORADO BLVD
N FOREST ST
N GRAPE ST
N IVY ST
N KEARNEY ST
N MONACO ST
N ONEIDA ST
N NEWPORT ST
N GARA ST
N OLIVE ST
N PONTIAC ST
N POPLAR ST
N QUEBEC ST
N SYRACUSE ST
N TRENTON ST
N ROSLYN ST
N ROSEMARY ST
N QUINCE ST
N SPRUCE ST
N DEXTER CT
N EUDORA ST
N FAIRFAX ST
N IVANHOE ST
N JASMINE ST
N KRAMERIA ST
N LEYDEN ST
N LOCUST ST
S MONACO PKWY
N MAGNOLIA ST
N NIAGARA ST
N JERSEY ST
N GLENCOE ST
N ELM ST
N FILBERT CT
N HOLLY ST
N CHERRY ST
N BELLAIRE ST
N BIRCH ST
N RICHARD ALLEN CT
N ALBION ST
N CLERMONT ST
SYRACUSE CT
S SPRUCE ST
FIGURE A.1
SAND CREEK AND UPPER PARK HILL BASINS WATERSHED MAP
Existing Storm Trunk Lines
Horiz. Diam. 0 - 18 in.
Horiz. Diam. 18 - 30 in.
Horiz. Diam. 30 - 48 in.
Horiz. Diam. 48 - 60 in.
Horiz. Diam. >60 in.
Storm Sewer Manhole
Storm Sewer Inlet
Sand Creek Existing Major Basin
Upper Park Hill Existing Major Basin
Routing Element
Design Point
38th/Holly Detention Pond
Railroads
Primary Basin ID
Sub-Basin ID
Basin Area
% Impervious
ATKINS
DENVER
0 290 580 1,160 Feet

Contributing Sub-Basins

Basin	Area	% Imperv.
10	51	59%
20	103	47%
20-1	60	45%
30	111	48%
30-1	82	48%
50	107	42%
60	100	43%
70	104	45%
75	135	47%
80	83	45%
80-1	83	48%
110	99	62%
110-1	42	65%
115	24	82%
120	12	53%
122	105	50%
	1301	**51.8%**

Summary of CUHP Input Parameters (Version 2.0.0)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
10	J10	5	0.079	0.263	0.548	0.012	59.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.90	0.27	57.42
20	J20	5	0.161	0.160	0.693	0.005	46.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.83	0.22	44.90
020-1	J20-1	5	0.093	0.201	0.574	0.007	45.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.83	0.22	43.46
30	J30	5	0.174	0.464	0.716	0.006	48.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.84	0.22	46.08
030-1	J30-1	5	0.129	0.411	0.861	0.004	48.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.84	0.22	46.14
50	J50	5	0.168	0.526	0.828	0.005	41.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.81	0.21	39.81
60	J60	5	0.156	0.435	0.749	0.002	43.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.81	0.21	40.94
70	J70	5	0.162	0.199	0.489	0.010	44.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.82	0.21	42.70
75	J75	5	0.212	0.294	0.900	0.007	46.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.83	0.22	44.94
80	J80	5	0.129	0.244	0.581	0.005	45.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.83	0.22	43.03
080-1	J80-1	5	0.129	0.277	0.643	0.004	47.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.84	0.22	45.60
110	J110	5	0.155	0.460	0.950	0.006	62.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.90	0.28	60.45
110-1	J110-1	5	0.065	0.219	0.437	0.006	64.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.91	0.28	63.07
115	J115	5	0.038	0.103	0.280	0.008	82.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.34	81.26
120	J120	5	0.165	0.323	0.706	0.010	53.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.24	51.30
122	J122	5	0.019	0.077	0.174	0.003	50.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.85	0.23	48.09

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.0)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
10		0.085	0.185	24.7	5.00	12.9	3.54	8.3	96	183,463	0.68	124,349	35.0	34	124,007	0.68
20		0.091	0.227	23.7	5.63	12.3	3.98	9.4	203	373,097	0.55	203,892	35.0	61	203,771	0.59
020-1		0.091	0.175	28.9	5.38	15.1	3.80	9.0	97	216,855	0.53	115,224	35.0	30	114,889	0.49
30		0.090	0.238	35.5	8.00	18.5	5.65	13.3	147	404,657	0.56	226,150	40.0	50	225,943	0.45
030-1		0.090	0.208	45.3	8.74	23.5	6.18	14.6	85	299,358	0.56	167,505	45.0	30	167,423	0.37
50		0.093	0.216	48.6	9.58	25.3	6.77	16.0	104	389,683	0.49	192,134	45.0	34	191,976	0.31
60		0.093	0.213	53.3	10.21	27.7	7.21	17.0	88	362,059	0.50	182,802	45.0	30	182,746	0.30
70		0.092	0.222	19.0	4.73	9.9	3.34	7.9	256	376,153	0.52	196,883	35.0	67	195,735	0.64
75		0.091	0.249	29.3	7.12	15.3	5.03	11.9	216	491,672	0.55	268,918	35.0	68	268,853	0.50
80		0.092	0.201	29.9	6.12	15.6	4.33	10.2	129	300,255	0.53	158,201	35.0	40	158,179	0.48
080-1		0.090	0.207	34.2	6.95	17.8	4.91	11.6	113	300,292	0.55	166,303	40.0	38	166,156	0.45
110		0.084	0.255	35.2	8.41	18.3	5.94	14.0	132	361,178	0.71	256,274	40.0	55	256,074	0.56
110-1		0.083	0.175	24.5	4.80	12.7	3.39	8.0	80	151,309	0.74	111,538	35.0	31	111,265	0.74
115		0.077	0.147	14.3	3.12	7.4	2.21	5.2	79	87,934	0.93	81,658	30.0	31	79,993	1.28
120		0.088	0.245	24.7	6.13	12.8	4.33	10.2	200	382,510	0.61	234,727	35.0	67	234,540	0.64
122		0.089	0.090	22.8	3.08	11.9	2.17	5.1	25	44,162	0.58	25,615	30.0	8	25,249	0.62

		CUHP 1.3.3		CUHP 2.0			
Catchment Name/ID	Area (sq.mi.)	Peak Flow (cfs)	Total Volume (c.f.)	Peak Flow (cfs)	Total Volume (c.f.)	% Difference in Peak	% Difference in Volume
10	0.079	69	163,693	34	124,007	-50.0%	-24.2%
20	0.161	123	281,698	61	203,771	-50.7%	-27.7%
020-1	0.093	63	162,061	30	114,889	-53.2%	-29.1%
30	0.174	105	313,382	50	225,943	-52.4%	-27.9%
030-1	0.129	67	231,842	30	167,423	-54.4%	-27.8%
50	0.168	74	274,828	34	191,976	-54.2%	-30.1%
60	0.156	65	260,003	30	182,746	-54.6%	-29.7%
70	0.162	138	275,799	67	195,735	-51.5%	-29.0%
75	0.212	151	376,247	68	268,853	-54.7%	-28.5%
80	0.129	86	222,874	40	158,179	-53.6%	-29.0%
080-1	0.129	80	230,984	38	166,156	-53.2%	-28.1%
110	0.155	116	337,458	55	256,074	-52.1%	-24.1%
110-1	0.065	61	144,538	31	111,265	-49.5%	-23.0%
115	0.038	54	98,796	31	79,993	-42.1%	-19.0%
120	0.165	137	317,600	67	234,540	-50.9%	-26.2%
122	0.019	16	35,180	8	25,249	-52.1%	-28.2%

B. Hydraulic Calculations

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)
--------------------------------------------------------------

Pond outlet reduced to 9"

WARNING 04: minimum elevation drop used for Conduit L10
WARNING 04: minimum elevation drop used for Conduit L20
WARNING 04: minimum elevation drop used for Conduit L20-1
WARNING 08: elevation drop exceeds length for Conduit L30
WARNING 04: minimum elevation drop used for Conduit L21
WARNING 04: minimum elevation drop used for Conduit L21-1
WARNING 04: minimum elevation drop used for Conduit L30-1
WARNING 04: minimum elevation drop used for Conduit L31-1
WARNING 04: minimum elevation drop used for Conduit L50
WARNING 04: minimum elevation drop used for Conduit L51
WARNING 08: elevation drop exceeds length for Conduit L80
WARNING 04: minimum elevation drop used for Conduit L81
WARNING 04: minimum elevation drop used for Conduit L81-1
WARNING 04: minimum elevation drop used for Conduit L80-1
WARNING 08: elevation drop exceeds length for Conduit 111DIV
WARNING 08: elevation drop exceeds length for Conduit L140
WARNING 04: minimum elevation drop used for Conduit L111
WARNING 04: minimum elevation drop used for Conduit L112
WARNING 08: elevation drop exceeds length for Conduit L115
WARNING 08: elevation drop exceeds length for Conduit 113DIV
WARNING 04: minimum elevation drop used for Conduit L113
WARNING 08: elevation drop exceeds length for Conduit L114
WARNING 08: elevation drop exceeds length for Conduit L141
WARNING 08: elevation drop exceeds length for Conduit L120
WARNING 08: elevation drop exceeds length for Conduit L122
WARNING 08: elevation drop exceeds length for Conduit L2
WARNING 08: elevation drop exceeds length for Conduit L111-1
WARNING 04: minimum elevation drop used for Conduit L110
WARNING 04: minimum elevation drop used for Conduit 111-1DIV
WARNING 04: minimum elevation drop used for Conduit L75
WARNING 04: minimum elevation drop used for Conduit L76
WARNING 04: minimum elevation drop used for Conduit L60
WARNING 04: minimum elevation drop used for Conduit L61
WARNING 04: minimum elevation drop used for Conduit L70
WARNING 04: minimum elevation drop used for Conduit L71
WARNING 08: elevation drop exceeds length for Conduit 39thAveSys
WARNING 04: minimum elevation drop used for Conduit L1112a
WARNING 08: elevation drop exceeds length for Conduit L120a

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
```

Flow Routing Method ..... KINWAVE
Starting Date 01/01/2005 00:00:00
Ending Date 01/03/2005 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Routing Time Step ..... 300.00 sec

Flow Routing Continuity	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	76.306	24.865
External Outflow	64.171	20.911
Flooding Loss	0.111	0.036
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	14.697	4.789
Continuity Error (%)	-3.504	

Highest Flow Instability Indexes

Link Pond (3)
Link 113DIV (3)
Link L1112 (2)
Link 2 (1)
Link O1111 (1)

Routing Time Step Summary

Minimum Time Step	:	300.00 sec
Average Time Step	:	300.00 sec
Maximum Time Step	:	300.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	1.01
Percent Not Converging	:	0.00

Node Depth Summary

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
J10	JUNCTION	0.00	0.00	5344.41	0 00:00	0.00
J20	JUNCTION	0.00	0.00	5331.57	0 00:00	0.00
J20-1	JUNCTION	0.00	0.00	5321.27	0 00:00	0.00
J30	JUNCTION	0.00	0.00	5324.00	0 00:00	0.00
J31	JUNCTION	0.04	0.94	5332.94	0 00:45	0.94
J30-1	JUNCTION	0.00	0.00	5308.74	0 00:00	0.00
J21	JUNCTION	10.40	10.40	5341.97	0 00:05	10.40
J21-1	JUNCTION	12.71	13.43	5334.70	0 00:50	13.43

J31-1	JUNCTION	15.34	16.21	5324.95	0	01:00	16.21
J50	JUNCTION	0.00	0.00	5300.73	0	00:00	0.00
J51	JUNCTION	15.30	16.28	5317.01	0	01:10	16.28
J81	JUNCTION	16.43	17.43	5311.00	0	01:15	17.43
J80	JUNCTION	0.00	0.00	5295.07	0	00:00	0.00
J80-1	JUNCTION	0.00	0.00	5285.43	0	00:00	0.00
J81-1	JUNCTION	16.53	17.58	5303.01	0	01:20	17.58
J110-1	JUNCTION	0.00	0.00	5275.43	0	00:00	0.00
J140	JUNCTION	0.00	0.00	5275.00	0	00:00	0.00
J112	JUNCTION	0.00	0.00	5264.66	0	00:00	0.00
J115	JUNCTION	0.00	0.00	5263.00	0	00:00	0.00
J114	JUNCTION	16.53	17.58	5273.05	0	01:20	17.58
J2	JUNCTION	1.81	4.30	5259.77	0	00:35	4.30
J141	JUNCTION	7.04	8.01	5277.01	0	00:50	8.01
J120	JUNCTION	0.00	0.00	5263.25	0	00:00	0.00
J122	JUNCTION	0.00	0.00	5263.25	0	00:00	0.00
J110	JUNCTION	0.00	0.00	5272.96	0	00:00	0.00
J75	JUNCTION	0.00	0.00	5279.89	0	00:00	0.00
J76	JUNCTION	8.13	8.93	5288.82	0	01:00	8.93
J72	JUNCTION	7.81	8.56	5298.79	0	00:40	8.56
J60	JUNCTION	0.00	0.00	5302.20	0	00:00	0.00
J61	JUNCTION	0.00	0.00	5302.20	0	00:00	0.00
J71	JUNCTION	0.00	0.00	5294.18	0	00:00	0.00
J70	JUNCTION	0.00	0.00	5294.18	0	00:00	0.00
FROMUPH	JUNCTION	0.00	0.00	5265.00	0	00:00	0.00
1	JUNCTION	0.73	2.56	5252.56	0	02:00	2.56
ToRundown	JUNCTION	0.03	0.89	5268.89	0	01:25	0.89
J120a	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
118	OUTFALL	0.00	0.00	5263.00	0	00:00	0.00
152	OUTFALL	0.73	2.54	5251.54	0	02:00	2.54
J1010	DIVIDER	11.60	11.60	5356.01	0	00:05	11.60
D1020-1	DIVIDER	12.71	13.66	5334.93	0	00:50	13.66
D1020	DIVIDER	10.41	11.17	5342.74	0	00:40	11.17
D1030	DIVIDER	15.32	16.34	5325.08	0	01:00	16.34
D1050	DIVIDER	15.33	16.34	5317.07	0	01:10	16.34
D1080	DIVIDER	16.43	17.49	5311.06	0	01:15	17.49
J1080-1	DIVIDER	16.53	17.47	5302.90	0	01:20	17.47
D1111	DIVIDER	10.74	11.73	5283.00	0	00:45	11.73
D111	DIVIDER	15.33	16.48	5281.14	0	01:15	16.48
D1113	DIVIDER	13.33	14.38	5279.04	0	01:15	14.38
D113	DIVIDER	7.84	9.28	5264.75	0	00:35	9.28
D1112	DIVIDER	17.16	36.43	5294.26	0	00:45	36.43
D111-1	DIVIDER	11.04	12.34	5285.30	0	01:15	12.34
D1113-1	DIVIDER	16.83	17.98	5285.18	0	01:10	17.98
D1111-1	DIVIDER	11.04	12.03	5284.99	0	00:40	12.03
D1075	DIVIDER	8.14	9.44	5289.33	0	01:05	9.44
D1071	DIVIDER	7.81	8.69	5298.83	0	00:45	8.69
D1060	DIVIDER	5.80	5.80	5308.00	0	00:05	5.80
D1070	DIVIDER	11.81	12.55	5306.73	0	00:40	12.55
DMONACO	DIVIDER	0.02	1.04	5323.04	0	01:05	1.04
WQToPond	DIVIDER	0.20	2.66	5260.49	0	00:35	2.66
R151	STORAGE	10.01	12.47	5266.47	0	04:15	12.47

****
Node Inflow Summary
****

		Maximum	Maximum			Lateral	Total	Flow

Node	Type	Lateral Inflow CFS	Total Inflow CFS	Time of Max Occurrence days	hr:min	Inflow Volume 10^6 gal	Balance Error Percent	Inflow Volume 10^6 gal
J10	JUNCTION	34.48	34.48	0	00:40	0.928	0.000	0.928
J20	JUNCTION	60.90	60.90	0	00:40	1.52	0.000	1.52
J20-1	JUNCTION	29.56	29.56	0	00:40	0.859	0.000	0.859
J30	JUNCTION	50.06	50.06	0	00:45	1.69	0.000	1.69
J31	JUNCTION	0.00	50.06	0	00:45	0	0.000	1.69
J30-1	JUNCTION	30.47	30.47	0	00:50	1.25	0.000	1.25
J21	JUNCTION	0.00	92.49	0	00:40	0	0.000	2.45
J21-1	JUNCTION	0.00	114.66	0	00:50	0	0.000	3.36
J31-1	JUNCTION	0.00	177.97	0	01:00	0	0.000	6.48
J50	JUNCTION	33.79	33.79	0	00:50	1.44	0.000	1.44
J51	JUNCTION	0.00	156.32	0	01:10	0	0.000	6.86
J81	JUNCTION	0.00	179.33	0	01:15	0	0.000	8.11
J80	JUNCTION	39.80	39.80	0	00:40	1.18	0.000	1.18
J80-1	JUNCTION	37.53	37.53	0	00:45	1.24	0.000	1.24
J81-1	JUNCTION	0.00	202.39	0	01:20	0	0.000	9.39
J110-1	JUNCTION	30.68	30.68	0	00:40	0.832	0.000	0.832
J140	JUNCTION	0.00	14.00	0	00:30	0	0.000	0.733
J112	JUNCTION	0.00	87.33	0	01:15	0	0.000	2.1
J115	JUNCTION	30.97	30.97	0	00:35	0.598	0.000	0.598
J114	JUNCTION	0.00	92.22	0	01:15	0	0.000	2.61
J2	JUNCTION	0.00	304.61	0	01:20	0	0.000	13.1
J141	JUNCTION	0.00	326.61	0	01:25	0	0.000	16.4
J120	JUNCTION	67.33	67.33	0	00:40	1.75	0.000	1.75
J122	JUNCTION	7.51	7.51	0	00:35	0.189	0.000	0.189
J110	JUNCTION	55.35	55.35	0	00:45	1.92	0.000	1.92
J75	JUNCTION	68.22	68.22	0	00:40	2.01	0.000	2.01
J76	JUNCTION	0.00	157.84	0	01:05	0	0.000	6.16

J72		JUNCTION	0.00	87.27	0	00:45	0
2.83	0.000						
J60		JUNCTION	29.68	29.68	0	00:50	1.37
1.37	0.000						
J61		JUNCTION	0.00	29.68	0	00:50	0
1.37	0.000						
J71		JUNCTION	0.00	66.79	0	00:40	0
1.46	0.000						
J70		JUNCTION	66.79	66.79	0	00:40	1.46
1.46	0.000						
FROMUPH		JUNCTION	89.63	89.63	0	02:00	4.62
4.62	0.000						
1		JUNCTION	0.00	96.33	0	02:00	0
12.9	0.000						
ToRundown		JUNCTION	0.00	221.27	0	01:20	0
6.54	0.000						
J120a		JUNCTION	0.00	355.99	0	01:25	0
18.2	0.000						
118		OUTFALL	0.00	149.45	0	00:50	0
7.99	0.000						
152		OUTFALL	0.00	95.35	0	02:00	0
12.9	0.000						
J1010		DIVIDER	0.00	34.48	0	00:40	0
0.928	0.000						
D1020-1		DIVIDER	0.00	114.66	0	00:50	0
3.36	0.000						
D1020		DIVIDER	0.00	92.49	0	00:40	0
2.45	0.000						
D1030		DIVIDER	0.00	177.97	0	01:00	0
6.48	0.000						
D1050		DIVIDER	0.00	156.32	0	01:10	0
6.86	0.000						
D1080		DIVIDER	0.00	179.33	0	01:15	0
8.11	0.000						
J1080-1		DIVIDER	0.00	202.39	0	01:20	0
9.39	0.000						
D1111		DIVIDER	0.00	127.07	0	00:45	0
6.91	0.000						
D111		DIVIDER	0.00	101.33	0	01:15	0
2.84	0.000						
D1113		DIVIDER	0.00	87.33	0	01:15	0
2.1	0.000						
D113		DIVIDER	0.00	149.45	0	00:50	0
7.99	0.000						
D1112		DIVIDER	0.00	275.99	0	01:25	0
11.8	0.000						
D111-1		DIVIDER	0.00	151.19	0	01:10	0
5.13	0.000						
D1113-1		DIVIDER	0.00	86.19	0	01:10	0
1.97	0.000						
D1111-1		DIVIDER	0.00	111.79	0	00:40	0
6.17	0.000						
D1075		DIVIDER	0.00	157.84	0	01:05	0
6.16	0.000						
D1071		DIVIDER	0.00	87.27	0	00:45	0
2.83	0.000						
D1060		DIVIDER	0.00	29.68	0	00:50	0
1.37	0.000						
D1070		DIVIDER	0.00	66.79	0	00:40	0
1.46	0.000						
DMONACO		DIVIDER	0.00	110.56	0	01:05	0
2.6	0.000						
WQToPond		DIVIDER	0.00	355.99	0	01:25	0

```
18.2       0.000
  R151                 STORAGE       0.00   304.61     0  01:20           0
13.1       0.004
```

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Volume 1000 ft3
D1112	1.75	0.81	0 00:50	0.036	0.000

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
R151	1118.642	23	0	0	1647.269	34	0 04:10	7.34

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
118	9.20	67.16	149.45	7.987
152	99.48	10.06	95.35	12.923
System	54.34	77.21	243.43	20.910

****
Link Flow Summary

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
L10	DUMMY	34.48	0	00:40			
L1010	CONDUIT	33.63	0	00:45	6.05	0.92	0.74
O-1010	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
L20	DUMMY	60.90	0	00:40			
L1020	CONDUIT	59.03	0	00:35	7.06	1.05	1.00
L20-1	DUMMY	29.56	0	00:40			
O1020	CONDUIT	32.04	0	00:50	7.85	0.00	0.04
L30	DUMMY	50.06	0	00:45			
L21	DUMMY	92.49	0	00:40			
L21-1	DUMMY	114.66	0	00:50			
L31	CONDUIT	45.48	0	01:00	2.80	0.00	0.05
L1020-1	CONDUIT	66.81	0	01:30	6.16	1.06	1.00
O1020-1	CONDUIT	42.03	0	01:05	8.41	0.00	0.04
L30-1	DUMMY	30.47	0	00:50			
L31-1	DUMMY	177.97	0	01:00			
L1030	CONDUIT	70.58	0	02:10	6.37	1.06	1.00
O1030	CONDUIT	110.56	0	01:05	4.93	0.00	0.05
L50	DUMMY	33.79	0	00:50			
L51	DUMMY	156.32	0	01:10			
L80	DUMMY	39.80	0	00:40			
L1050	CONDUIT	94.66	0	02:10	6.67	1.07	1.00
O1050	CONDUIT	65.99	0	01:15	6.77	0.00	0.05
L81	DUMMY	179.33	0	01:15			
L1080	CONDUIT	93.68	0	02:25	7.27	1.00	1.00
O1080	CONDUIT	84.63	0	01:20	9.38	0.00	0.05
L81-1	DUMMY	202.39	0	01:20			
L80-1	DUMMY	37.53	0	00:45			
L-1080-1	CONDUIT	113.72	0	02:30	8.53	1.06	1.00
O1080-1	CONDUIT	93.86	0	01:25	11.05	0.00	0.05
L1111	CONDUIT	48.68	0	02:35	4.55	1.04	1.00
O1111	CONDUIT	79.79	0	00:50	9.14	0.00	0.05
111DIV	DUMMY	14.00	0	00:30			
L140	DUMMY	14.00	0	00:30			
L110-1	DUMMY	30.68	0	00:40			
L1113	CONDUIT	2.40	0	02:10	3.58	1.00	1.00
O1113	CONDUIT	84.33	0	01:20	8.44	0.00	0.05
L111	DUMMY	87.33	0	01:15			
L112	DUMMY	87.33	0	01:15			
L115	DUMMY	30.97	0	00:35			
113DIV	DUMMY	149.45	0	00:50			
L113	DUMMY	0.00	0	00:00			
L114	DUMMY	92.22	0	01:15			
L141	DUMMY	326.61	0	01:25			
L1112	CONDUIT	147.06	0	00:50	7.05	1.01	0.92
O1112	CONDUIT	129.89	0	01:25	7.79	0.00	0.04
L120	DUMMY	67.33	0	00:40			
L122	DUMMY	7.51	0	00:35			
L2	DUMMY	304.61	0	01:20			
L1113-1	CONDUIT	3.07	0	00:45	4.52	1.00	1.00
O1113-1	CONDUIT	82.02	0	01:15	7.21	0.00	0.06
L111-1	DUMMY	86.19	0	01:10			
L110	DUMMY	55.35	0	00:45			
L1111-1	CONDUIT	51.58	0	02:30	4.96	1.00	1.00
O1111-1	CONDUIT	61.67	0	00:45	5.95	0.00	0.05
111-1DIV	DUMMY	65.00	0	00:40			
L1075	CONDUIT	47.29	0	02:15	5.99	1.01	1.00

O1075	CONDUIT	110.18	0	01:15	5.93	0.00	0.07
L75	DUMMY	68.22	0	00:40			
L76	DUMMY	157.84	0	01:05			
L1071	CONDUIT	44.95	0	01:40	5.47	1.06	1.00
O1071	CONDUIT	36.85	0	01:00	7.25	0.00	0.04
L72	DUMMY	87.27	0	00:45			
L1060	CONDUIT	29.46	0	01:00	5.65	0.83	0.70
O1060	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
L60	DUMMY	29.68	0	00:50			
L61	DUMMY	29.68	0	00:50			
L1070	CONDUIT	19.07	0	01:30	4.37	1.06	1.00
O1070	CONDUIT	50.42	0	00:40	7.04	0.00	0.04
L70	DUMMY	66.79	0	00:40			
L71	DUMMY	66.79	0	00:40			
MWEST	CONDUIT	60.57	0	01:10	5.34	0.00	0.05
MNORTH	CONDUIT	43.16	0	01:25	8.64	0.00	0.04
39thAveSys	DUMMY	89.63	0	02:00			
2	CONDUIT	95.35	0	02:00	8.84	0.44	0.46
L1112a	DUMMY	275.99	0	01:25			
Pond	CONDUIT	80.93	0	00:35	9.07	0.79	0.67
Rundown	DUMMY	221.27	0	01:20			
L120a	DUMMY	355.99	0	01:25			
OUT151	DUMMY	7.34	0	04:15			

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
L1020	0.58	0.58	0.58	0.17	0.58
L1020-1	0.83	0.83	0.83	0.92	0.83
L1030	1.50	1.50	1.50	0.17	1.50
L1050	1.58	1.58	1.58	1.58	1.58
L1080	1.58	1.58	1.58	1.75	1.58
L-1080-1	1.75	1.75	1.75	1.75	1.75
L1111	2.00	2.00	2.00	2.08	2.00
L1113	1.58	1.58	1.58	1.67	1.58
L1112	1.67	1.67	1.67	1.67	1.67
L1113-1	1.25	1.25	1.25	1.33	1.25
L1111-1	1.92	1.92	1.92	2.00	1.92
L1075	1.75	1.75	1.75	1.83	1.75
L1071	1.00	1.00	1.00	1.08	1.00
L1070	1.00	1.00	1.00	0.08	1.00

Analysis begun on: Wed Jan 25 14:30:38 2017
Analysis ended on: Wed Jan 25 14:30:38 2017
Total elapsed time: < 1 sec

C. Detention Pond Calculations

Proposed Pond Volume
Project: 38th and Holly
Basin Description:

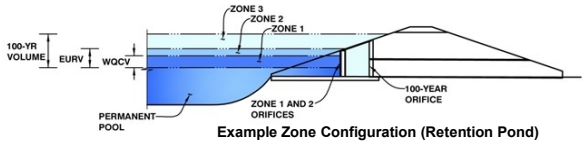
Contour Elevation	Contour Area (SF)	Depth (FT)	Incremental Volume Avg. End (CF)	Cumulative Volume Avg. End (CF)	Cumulative Volume Avg. End (AC-FT)
5,253.00	94.35	N/A	N/A		
5,254.00	690.08	1	392.22	392.22	
5,255.00	10,803.78	1	5746.93	6139.15	0.14
5,256.00	59,412.71	1	35108.25	41247.39	0.95
5,257.00	101,859.51	1	80636.11	121883.50	2.80
5,257.50	116,383.41	0.5	54560.73	176444.23	4.05
5,258.00	130,907.31	0.5	61822.68	238266.91	5.47
5,259.00	146,459.28	1	138683.30	376950.21	8.65
5,260.00	161,793.97	1	154126.63	531076.83	12.19
5,261.00	174,680.12	1	168237.05	699313.88	16.05
5,262.00	184,442.22	1	179561.17	878875.05	20.18
5,263.00	194,353.85	1	189398.04	1068273.08	24.52
5,264.00	203,543.38	1	198948.62	1267221.70	29.09
5,265.00	213,146.82	1	208345.10	1475566.80	33.87
5,266.00	223,876.52	1	218511.67	1694078.47	38.89
5,267.00	235,406.35	1	229641.44	1923719.90	44.16
5,268.00	246,716.92	1	241061.64	2164781.54	49.70

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	9.54	22.067	Orifice Plate
Zone 2 (5-year)	#REF!	36.709	Weir&Pipe (Circular)
Zone 3			
		58.777	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.80	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	10.89	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	7.563E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.14	1.62	3.10					
Orifice Area (sq. inches)	10.89	10.89	10.89					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Slope =			H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =			feet
Overflow Grate Open Area % =			%, grate open area/total area
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Over Flow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Circular	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =		feet
Spillway End Slopes =		H:V
Freeboard above Max Water Surface =		feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.83	1.11	1.33	1.69	1.99	2.38	3.14
Calculated Runoff Volume (acre-ft) =	22.067	60.213	39.251	62.357	82.658	126.293	159.275	206.219	294.906
OPTIONAL Override Runoff Volume (acre-ft) =	4.000								
Inflow Hydrograph Volume (acre-ft) =	3.998	60.185	39.224	62.326	82.557	126.174	159.175	206.107	294.682
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.05	0.16	0.43	0.59	0.84	1.30
Predevelopment Peak Q (cfs) =	0.0	0.0	8.3	70.8	205.1	557.8	771.3	1092.7	1686.1
Peak Inflow Q (cfs) =	39.3	507.7	348.0	523.0	679.9	991.2	1224.0	1544.4	2127.9
Peak Outflow Q (cfs) =	1.8	4.4	3.7	4.5	5.2	6.7	7.8	9.5	12.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.0	0.0	0.0	0.0
Structure Controlling Flow =	Plate	#REF!	Plate	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	>120	172	>120	>120	>120	>120	>120	>120
Time to Drain 99% of Inflow Volume (hours) =	**40**	>120	182	>120	>120	>120	>120	>120	>120
Maximum Ponding Depth (ft) =	4.35	17.14	12.92	17.57	21.64	30.42	37.07	46.52	64.35
Area at Maximum Ponding Depth (acres) =	2.43	6.13	5.27	6.13	6.13	6.13	6.13	6.13	6.13
Maximum Volume Stored (acre-ft) =	3.574	50.009	38.307	50.009	50.009	50.009	50.009	50.009	50.009

48'' HERCP

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Rise	3.17	ft
Span	5.00	ft

Results

Discharge	97.84	ft³/s
Normal Depth	3.17	ft
Flow Area	12.45	ft²
Wetted Perimeter	12.98	ft
Hydraulic Radius	0.96	ft
Top Width	0.00	ft
Critical Depth	2.52	ft
Percent Full	100.0	%
Critical Slope	0.00496	ft/ft
Velocity	7.86	ft/s
Velocity Head	0.96	ft
Specific Energy	4.13	ft
Froude Number	0.00	
Maximum Discharge	106.63	ft³/s
Discharge Full	97.77	ft³/s
Slope Full	0.00499	ft/ft
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

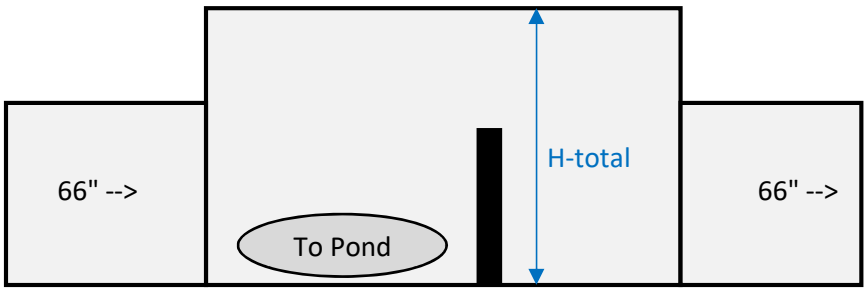
48'' HERCP

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.17	ft
Critical Depth	2.52	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00496	ft/ft

38th & Holly Diversion Structure

66" pipe @ 0.5%	
Wall Height (ft)	3.75
C	2.6
L (ft)	8
Q-In	237.44
Q-Out	139.44
H-above wall	3.56
H-total (ft)	7.31



Area above wall	28.44	ft^2
Area of 66" pipe	23.75	ft^2

66'' Storm Sewer

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	5.50	ft
Diameter	5.50	ft

Results

Discharge	237.44	ft^3/s
Flow Area	23.76	ft^2
Wetted Perimeter	17.28	ft
Hydraulic Radius	1.38	ft
Top Width	0.00	ft
Critical Depth	4.31	ft
Percent Full	100.0	%
Critical Slope	0.00547	ft/ft
Velocity	9.99	ft/s
Velocity Head	1.55	ft
Specific Energy	7.05	ft
Froude Number	0.00	
Maximum Discharge	255.42	ft^3/s
Discharge Full	237.44	ft^3/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Muller Engineering Company, Inc.
DESIGN NOTES AND COMPUTATIONS

Subject: 38th & Holly Forebay Design Sheet No. 1 Of _____

Prepared By: SJT Checked By: _____ Date: 11/21/17 Project No.: 17-010.03

Forebay needs to contain the volume of 3% of the portion of WQCV entering the pond at the 48" HERCP

48" HERCP capacity from FlowMaster:

Roughness Coefficient = 0.013
Slope = 0.5%
Normal Depth = 3.17 ft
Rise = 3.17 ft
Span = 5 ft

Discharge (Q_{100}) = 97.84 cfs

Total flow into pond = 221 cfs + 97.84 cfs = 318.84 cfs
maximum flow in Holly St. ←

Portion of flow entering via 48" HERCP = $\frac{97.84 \text{ cfs}}{318.84 \text{ cfs}} = 0.31 \rightarrow 31\%$

Volume of forebay = 0.31 (0.03 (4 acre-feet))
= 0.037 acre-feet

Forebay Depth (D_F) = 12 inches

Forebay Discharge Design Flow (Q_F) = 0.02 Q_{100}
= 0.02 (97.84 cfs) = 1.96 cfs

Rectangular Notch Width (W_N) = $\left(\frac{Q_F}{3.33(D_F/12)^{1.5}}\right)12 + 0.2(D_F)$

$= \left(\frac{1.96 \text{ cfs}}{3.33\left(\frac{12 \text{ in}}{12}\right)^{1.5}}\right)12 + 0.2(12 \text{ in}) = 9.5 \text{ in.}$

D. Drop Structure Calculations

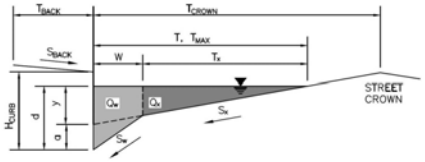
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Enter Your Project Name Here

Inlet ID: Ex Street Inlet



Gutter Geometry (Enter data in the blue cells)

	Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
	Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Warning 01	Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.035	
	Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
	Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
	Gutter Width	W =	2.00	ft
	Street Transverse Slope	S_X =	0.038	ft/ft
	Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
	Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
	Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

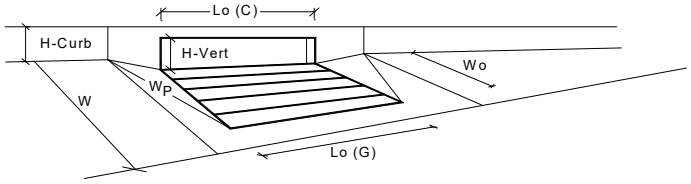
			Minor Storm	Major Storm	
	Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	14.0	15.0	ft
Warning 02	Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.2	8.0	inches
	Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

Warning 01: Manning's n-value does not meet the USDCM recommended design range.

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

			MINOR	MAJOR	
	Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
	Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
	Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
	Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.2	7.9	inches

			MINOR	MAJOR	
	Grate Information				☐ Override Depths
	Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
	Width of a Unit Grate	W_o =	1.73	1.73	feet
	Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
	Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
	Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
	Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
	Curb Opening Information		MINOR	MAJOR	
	Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
	Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
	Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
	Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
	Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
	Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
	Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
	Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

			MINOR	MAJOR	
	Low Head Performance Reduction (Calculated)				
	Depth for Grate Midwidth	d_{Grate} =	0.539	0.683	ft
	Depth for Curb Opening Weir Equation	d_{Curb} =	0.35	0.49	ft
	Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.73	0.93	
	Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
	Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.73	0.93	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**6.8**	**12.5**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Major Storm	$Q_{PEAK\ REQUIRED}$ =	6.8	221.0	cfs

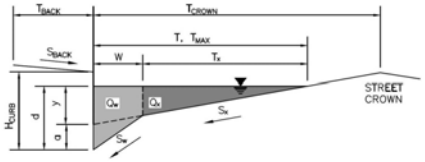
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Enter Your Project Name Here

Inlet ID: Ex Street Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Warning 01 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.035	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	21.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.038	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

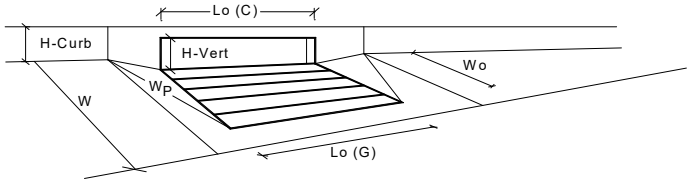
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	14.0	15.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.0	5.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

Warning 01: Manning's n-value does not meet the USDCM recommended design range.

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)

		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.0	5.0	inches

Grate Information

		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)

		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.356	0.439	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.17	0.25	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.47	0.59	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.97	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.47	0.59	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**2.0**	**3.8**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Minor and Major Storms	$Q_{PEAK\ REQUIRED}$ =	6.8	221.0	cfs

12'' Pipe

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.03660	ft/ft
Normal Depth	1.00	ft
Diameter	1.00	ft

Results

Discharge	6.82	ft^3/s
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Hydraulic Radius	0.25	ft
Top Width	0.00	ft
Critical Depth	0.97	ft
Percent Full	100.0	%
Critical Slope	0.03234	ft/ft
Velocity	8.68	ft/s
Velocity Head	1.17	ft
Specific Energy	2.17	ft
Froude Number	0.00	
Maximum Discharge	7.33	ft^3/s
Discharge Full	6.82	ft^3/s
Slope Full	0.03660	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Broad Crested Weir - CBC

Project Description

Solve For	Discharge

Input Data

Headwater Elevation		5269.36	ft
Crest Elevation		5267.46	ft
Tailwater Elevation		5266.30	ft
Crest Surface Type	Paved		
Crest Breadth		10.00	ft
Crest Length		40.00	ft

Results

Discharge	320.84	ft³/s
Headwater Height Above Crest	1.90	ft
Tailwater Height Above Crest	-1.16	ft
Weir Coefficient	3.06	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	3.06	US
Flow Area	76.00	ft²
Velocity	4.22	ft/s
Wetted Perimeter	43.80	ft
Top Width	40.00	ft

Flow Depth in CBC

Project Description

Solve For	Headwater Elevation

Input Data

Discharge		214.00	ft³/s
Crest Elevation		5267.46	ft
Tailwater Elevation		5266.30	ft
Crest Surface Type	Paved		
Crest Breadth		10.00	ft
Crest Length		40.00	ft

Results

Headwater Elevation	5268.92	ft
Headwater Height Above Crest	1.46	ft
Tailwater Height Above Crest	-1.16	ft
Weir Coefficient	3.04	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	3.04	US
Flow Area	58.31	ft²
Velocity	3.67	ft/s
Wetted Perimeter	42.92	ft
Top Width	40.00	ft

38th and Holly Drop Structure

Weir Calculation					
Drop	Q (cfs)	q (cfs/ft)	Length (ft)	C	H (ft)
A	214	5.49	39	2.6	1.65
B	214	4.55	47	2.6	1.46
C	214	5.22	41	2.6	1.60
D	221	6.14	36	2.6	1.78
E	221	7.37	30	2.6	2.01
F	221	9.21	24	2.6	2.33

Y_f (ft)					
Drop A	**Drop B**	**Drop C**	**Drop D**	**Drop E**	**Drop F**
0.70	1.20	2.15	1.40	2.15	1.20

Drop Number Equation: $$\mathbf{D_n = \frac{q^2}{(gY_f^3)}}$$

Gravity (g) 32.2 ft/s^2

Drop Number - D_n					
Drop A	**Drop B**	**Drop C**	**Drop D**	**Drop E**	**Drop F**
2.7261	0.3726	0.0851	0.4265	0.1696	1.5239

$$\mathbf{L_d(ft) = 4.3D_n^{0.27}Y_f}$$

L_d (ft)					
Drop A	**Drop B**	**Drop C**	**Drop D**	**Drop E**	**Drop F**
3.95	3.95	4.75	4.78	5.73	5.78