

**CITY OF SPRINGDALE**  
**Committee Agendas**  
**Monday, May 3, 2021**  
**City Council Chambers**  
**City Administration Building**  
**Meetings begin at 5:30 P.M.**

**Police and Fire Committee by Chairman Brian Powell**

1. **An Ordinance** to waive competitive bidding for the purchase of a Work Ready Fitness Assessment. Resolution presented by Chief Mike Irwin, Springdale Fire Department. Pgs. 2 - 4
2. **A Resolution** authorizing the Mayor and City Clerk to enter into a Memorandum of Understanding between the City of Springdale, the City of Fayetteville, and Washington County, Arkansas. Resolution presented by Chief Mike Irwin, Springdale Fire Department. Pgs. 5 - 11
3. **Four Minute Drive Time Presentation** presented by Chief Mike Irwin, Springdale Fire Department.

**Finance Committee by Chairman Jeff Watson**

4. **A Resolution** authorizing the purchase of property located at 3377 W. Huntsville Avenue, Springdale, Washington County, Arkansas. Resolution presented by Ernest Cate, City Attorney. Pgs. 12 - 14
5. **A Resolution** authorizing the Mayor and City Clerk to execute an Option Agreement for the purchase of real estate (McCollough Dr.) owned by the City of Springdale. Resolution presented by Ernest Cate, City Attorney. Pgs. 15 - 24
6. **A Resolution** authorizing the Mayor and City Clerk to execute a Right of First Refusal Agreement on property (6476 Downum Rd.) owned by the City of Springdale. Resolution presented by Ernest Cate, City Attorney. Pgs. 25 - 30
7. **A Resolution** authorizing the execution of a Construction Contract and a Change Order for Park Street Project No. 18BPS13. Resolution presented by Brad Baldwin, City Engineer. Pgs. 31 - 44

**Discussions**

8. **A Discussion:** Neal Johnson, Chairman of the Springdale Airport Commission - Airport Hangar.
9. **A Discussion:** Brad Baldwin, City Engineer - Amendment to Low Impact Development Design. Pgs. 45 - 133



**ORDINANCE NO. \_\_\_\_\_**

**AN ORDINANCE TO WAIVE COMPETITIVE  
BIDDING FOR THE PURCHASE OF A WORK  
READY FITNESS ASSESSMENT**

**WHEREAS**, the Fire Department has funds in their 2021 budget for a fitness assessment,  
and

**WHEREAS**, they have arranged for O2X to provide this service, and

**WHEREAS**, the \$26,325 cost of this service will exceed the amount where competitive  
bids are required, and

**WHEREAS**, Arkansas Code 14-58-303 states, "The governing body, by ordinance, may  
waive the requirements of competitive bidding in exceptional situations where this procedure is  
deemed not feasible or practical";

**NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL FOR THE  
CITY OF SPRINGDALE, ARKANSAS, that**

**Section 1.** Due to the specialty of this service competitive bidding is deemed not  
practical and competitive bidding on the purchase of the furnishing of a work ready fitness  
assessment and is here by waived with the services to be provided by O2X for \$26,325.

**Section 2. Emergency Clause.** It is hereby declared that an emergency exists, and this  
ordinance being necessary for the immediate preservation of the health, safety, and welfare of the  
citizens of Springdale, Arkansas, shall be effective immediately upon passage and approval.

**PASSED AND APPROVED** this 11<sup>th</sup> day of May, 2021

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST:

\_\_\_\_\_  
Denise Pearce, City Clerk

APPROVED AS TO FORM

\_\_\_\_\_  
Ernest B. Cate, City Attorney



**Wyman Morgan**

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**From:** Mike Irwin <mirwin@springdalear.gov>  
**Sent:** Tuesday, April 27, 2021 2:01 PM  
**To:** 'Wyman Morgan'  
**Subject:** Waive competitive bidding!

Wyman,

As was approved by city council in our budget for 2021, we had contracted with a company called, **O2X** to supply our department with a work ready fitness assessment, as well as access to nutrition, workouts, mental health, and a full array of wellness tools to better allow our members personalized programs to help them maintain fitness or improve. When all was said and done, we were not completely sure how much the program would total out, but when we received the bill it was over the \$20,000 limit before it goes out for bid. Since we had researched many companies and felt this one filled our needs better than most, I would like to ask for the council to waive competitive bidding for this. We have received the bill and I have it over at the city clerk's office along with the proper paperwork to get them as a vendor. I am sorry I did not think of the waiving of competitive bidding before the process.

*Michael J. Irwin*  
Fire Chief  
Springdale Fire Department



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## Wyman Morgan

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**From:** Mike Irwin <mirwin@springdalear.gov>  
**Sent:** Monday, April 26, 2021 5:09 PM  
**To:** 'Wyman Morgan'  
**Subject:** Invoice?

Wyman,

I may have goofed on one of the professional services that we contracted for with the total fitness side for the department. If you remember I had asked to increase our professional services to bring in a company that would offer a whole host of fitness/mental health things for our members. We have received the invoice and it totals \$26,325. I did not even think about the total being over \$20,000 for waiving competitive bids? What would you like me to do as I want to make sure and be transparent with the actions we do? Just let me know and sorry about that miss on my part!

*Michael J. Irwin*

Fire Chief  
Springdale Fire Department



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RESOLUTION NO. \_\_\_\_\_

**A RESOLUTION AUTHORIZING THE MAYOR AND  
CITY CLERK TO ENTER INTO A MEMORANDUM OF  
UNDERSTANDING BETWEEN THE CITY OF  
SPRINGDALE, THE CITY OF FAYETTEVILLE, AND  
WASHINGTON COUNTY, ARKANSAS.**

**WHEREAS**, the City of Springdale, the City of Fayetteville, and Washington County, Arkansas (collectively referred to herein as "the Parties"), each wish to make improvements to certain radio communication frameworks;

**WHEREAS**, the Parties wish to establish an understanding and agreement among the Parties related to ownership and responsibilities for a unified and shared infrastructure of the Arkansas Wireless Information Network (AWIN) operating in Washington County, Arkansas, which benefits the public safety and public service officials serving the citizens of the region;

**WHEREAS**, the Parties wish to enter into a Memorandum of Understanding (attached hereto as Exhibit "A") to memorialize their agreement as it pertains to these issues, and to set forth the terms and conditions pertaining thereto;

**NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL FOR THE CITY OF SPRINGDALE, ARKANSAS**, that the Mayor and City Clerk are hereby authorized to execute a Memorandum of Understanding, a copy of which is attached to this Resolution.

**PASSED AND APPROVED** this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST:

\_\_\_\_\_  
Denise Pearce, CITY CLERK

APPROVED AS TO FORM:

\_\_\_\_\_  
Ernest B. Cate, CITY ATTORNEY



## MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding is entered into on behalf of the City of Fayetteville, Arkansas, the City of Springdale, Arkansas and the County of Washington, Arkansas. All parties acknowledge that this MOU is executed for good and valuable consideration.

### **Introduction:**

In order to support the mission-critical communication needs of each localities individual and collective public safety and public service personnel, the parties to this agreement have or desire to improve certain radio communication frameworks. Improvements such as enhanced system connectivity, geographic redundancy of system control equipment, direct inter-agency interoperability, and greater RF coverage will be realized by taking advantage of an opportunity to pool resources and needs, which will collectively benefit all parties, and agree this opportunity is best realized through joint action.

### **Purpose:**

The purpose of this Memorandum of Understanding is to establish an understanding and agreement among the parties related to ownership and responsibilities for a unified and shared infrastructure of the Arkansas Wireless Information Network (AWIN) operating in and near Washington County, Arkansas. This agreement provides for a working relationship among parties, which benefits the public-safety and public service officials servicing the citizens of the region. The parties to the agreement expect over time, the particular components of the System may change as operational and capacities needs change.

### **Understanding:**

It is understood that the City of Fayetteville and the City of Springdale both operate P25 trunked simulcast radio systems with associated control equipment known as a Simulcast Prime Site, both operating in conjunction with the SmartZone Controllers that are located in Little Rock, Arkansas at DIS and at the Arkansas Department of Emergency Management (ADEM). These AWIN SmartZone Controllers and the associated equipment are vital for two-way radio communications among various entities around the State, and are a critical link in the City's and County's two-way AWIN radio communications. It is understood that Washington County is replacing and upgrading its proprietary public safety radio system with a P25 trunked simulcast radio system also in conjunction with AWIN. If implemented alone, Washington County, Fayetteville, and Springdale would each operate separate trunked simulcast systems each with its own dedicated Simulcast Prime Site. Upgrading and integrating the existing Fayetteville and Springdale Simulcast Prime Sites, and adding additional Washington County simulcast tower sites, provides for geographic system control redundancy that is not currently



present, improves inter-agency interoperability, enhances system coverage, and increases system reliability.

**Agreement:**

In exchange for the mutual considerations received and given by the County of Washington, Arkansas, City of Fayetteville Arkansas and City of Springdale Arkansas, all parties agree to the following:

1. The City of Fayetteville agrees to allow Washington County and the City of Springdale reasonable use of its Prime Site and associated equipment necessary for transmitting and receiving voice and data communication as part of the City's communication system operations.
2. The City of Springdale agrees to allow Washington County and the City of Fayetteville reasonable use of its Prime Site and associated equipment necessary for transmitting and receiving voice and data communication as part of the City's communication system operations.
3. At the expense of Washington County, additional tower sites will be added for the improved coverage of the system that will be integrated and interoperable with the City of Fayetteville and City of Springdale simulcast sites and controllers. These sites will be operational as part of the AWIN system. This includes adding additional microwave hops to Springdale and providing MPLS backhaul routers to the sites providing for an alternate connection path for all entities in the county to the AWIN Smartzone Controllers.
4. The upgraded system will provide public safety grade capacity for the Police, Fire, EMS, and Emergency Management users of Washington County, Fayetteville, and Springdale with the ability for additional capacity to be added. The Public Safety grade capacity industry standard is a Grade of Service (GOS) of 2%, or less. The capacity design goal for the upgraded county-wide system is 1.2%, or less. If project funding allows, Washington County will purchase a seventh county-wide simulcast channel to expand upon the six-channel capacity of the Springdale simulcast system going from 10 TDMA talk paths to 12 TDMA talk paths. This 12 TDMA county-wide talk path capacity design exceeds the Public Safety Grade of Service (GOS) standard design criteria for all Washington County, Fayetteville, and Springdale user agencies. The addition of the seventh channel hardware also provides for the future expansion of up to five additional channels by way of line cards that insert into the new seventh channel hardware assemblies requiring no additional rack space or antenna system changes at any simulcast site.
5. At the expense of Washington County, Motorola will provide Edge Availability which provides site-to-site communications, roaming, and wireline dispatch by grouping together local sites. This feature maintains the maximum level of trunking services, coverage, and access to talkgroups, even if sites should become detached from the Controllers.



6. At the expense of Washington County, Motorola will integrate the City of Fayetteville and City of Springdale Prime sites to make them geographically redundant Prime sites, providing additional layers of redundancy to the systems.
7. At the expense of Washington County, Motorola will upgrade the Fayetteville APX subscribers to TDMA (Time Division Multiple Access) and reprogram all police and fire radios with new fleetmaps.
8. If needed by Washington County for the county-wide simulcast system the City of Fayetteville agrees that Washington County can use its excess GTR repeater equipment for use at the County's Lincoln Lake ASR tower site or at other Washington County simulcast tower sites. Washington County understands this GTR repeater equipment is owned by the City of Fayetteville. Furthermore, if in the future there is a need for additional like equipment on the system, the County acknowledges that this GTR repeater equipment is Fayetteville's contribution.
9. All parties agree that each entity is responsible for their own tower site locations and any related expenses such as lease expense and maintenance costs.
10. Each City agrees to allow Washington County access to their existing simulcast system frequencies to allow for the configuration of the county-wide simulcast system. Washington County will be responsible for all costs associated with any FCC licensing fees incurred to utilize these frequencies for the county-wide simulcast system.
11. The tower sites identified here;  
Washington County:
  - 1) Hazel Valley
  - 2) Winslow
  - 3) Hale Mountain
  - 4) Lincoln LakeFayetteville:
  - 1) Sequoyah Water Tank (Simulcast Prime Site)
  - 2) Dinsmore Trail
  - 3) FulbrightSpringdale:
  - 1) Dodd Water Tank (Simulcast Prime Site)
  - 2) Children's Hospital;are considered to be a critical part of the AWIN system and serve various public-safety entities and first responders from multiple agencies to advance the Federal, State and City's goals of interoperable communications. During the term of this agreement, all entities agree to allow the identified tower sites to remain part of AWIN system and, except as is provided in this agreement, shall not take action restricting the use of, access to, or limiting the capabilities necessary to maintain interoperable communications utilizing the tower sites. Nothing in this agreement shall preclude the entity from making additions to or allowing non-AWIN-related equipment at the identified tower sites, if proper propagation, interference



analysis, and tower-loading studies are conducted and no significant adverse impact results to AWIN operations. If the entity proposes additional non-AWIN related equipment or users, the entity agrees to provide copies of the aforementioned studies and user information to AWIN system managers, prior to the final approval of any equipment placement, for input and proper record keeping purposes

- a. Reasonable efforts to adhere to R-56 grounding standards should be made when adding or modifying any equipment in the sites.
  - b. Expansions or changes to the system will require coordination with the other entities involved and all parties agree to submit plans for review and approval to one another and the State for final approval prior to procurement.
12. All entities agree that all parties involved will develop radio programming consistent with operational requirements, taking into consideration the loading characteristics of the AWIN network. Further, agree to utilize the existing interoperability radio programming guidelines established by AWIN and the fleetmap design for NWA Regional talkgroups.
13. All entities will be individually responsible for maintaining adequate insurance on equipment and infrastructure owned by their respective jurisdictions.

**Maintenance:**

1. Each entity is responsible for their own tower site maintenance and lease expenses.
2. Ensuring the generators and all equipment connected to the generators necessary for generator operations are properly maintained and insured. Maintenance is handled in a timely manner.
3. Weed control, site mowing, road maintenance, fencing and signage at the City and County controlled tower sites. No site will be identified as an AWIN site for security purposes.
4. Controlling access to the tower sites and allowing employees, contractors, and subcontractors of the State access to the tower sites (including any buildings and equipment located thereon) as long as this agreement is in place.

**Oversight:**

Each locality subject to this agreement shall appoint two representatives to a committee for working collaboratively on trunked radio system issues and needs. These members will also work towards a goal of a regional communications plan for the NWA Metropolitan area. Ideally, these individuals are familiar with radio system management



and are in a position to convey information about any needs in the system moving forward to their respective City and County leadership. Any future expansion or enhancements recommendations will need to be brought forward through each entity's approval and budget processes.

#### **Right to Cancel or Amend**

The Parties recognize the importance of public-safety communications and that disruptions may create life-threatening situations. Neither party may unilaterally cancel the agreement contained herein during the term of this agreement. This agreement shall continue until either party gives the other party twenty-four (24) months advance written notice of an intention to cancel this agreement, which may be based on, but not limited to, the absence of funding necessary to perform the obligations of the party giving such notice. This agreement may be amended at any time upon mutual written agreement of the parties.

#### **Conflict with Law**

Any conflict between this agreement and laws subsequently established shall result in the conflicting provisions of this agreement being superceded by such law. In such event, any party whose rights or obligations are adversely affected by such subsequent law shall have the right to issue to the other party a notice of termination of the affected party's obligations under this agreement effective on the effective date of such subsequent law.

#### **Entire Agreement**

Neither party to this agreement is the agent of the other for the purposes of this agreement. No employee or contractor of one party shall become the employee or agent of the other party by participating in the joint communication activities of this agreement.

This Memorandum of Understanding contains the entire agreement of all parties, and all prior communications, oral or written, are without any force and effect, as it is the specific intent of the parties that this agreement alone sets forth the terms on which the parties have mutually agreed. Each party specifically agrees that it enters into this agreement based on its own understanding of the terms hereof and does not rely, in whole or in part, on any interpretation or representation of the other party. Each party agrees that this agreement is the result of good faith, arms-length negotiations.



On this \_\_\_\_\_ day of \_\_\_\_\_ 2021.

Washington County

By:  \_\_\_\_\_  
34F19482757444F  
Judge

By:  \_\_\_\_\_  
ABF7527CDFB845C  
County Attorney

City of Springdale

By: \_\_\_\_\_  
Mayor

Attest:  
By: \_\_\_\_\_  
City Clerk

City of Fayetteville

By: \_\_\_\_\_  
Mayor

Attest:  
By: \_\_\_\_\_  
City Clerk



RESOLUTION NO. \_\_\_\_\_

**A RESOLUTION AUTHORIZING THE PURCHASE OF  
PROPERTY LOCATED AT 3377 W. HUNTSVILLE  
AVENUE, SPRINGDALE, WASHINGTON COUNTY,  
ARKANSAS.**

**WHEREAS**, Brandee Madewell currently owns property located at 3377 W. Huntsville Avenue, Springdale, Washington County, Arkansas, Parcel Number 815-29875-030, ("the Property"), and more particularly described as follows:

A part of the Northeast Quarter of the Southwest Quarter of Section 34, Township 18 North, Range 30 West, being more particularly described as follows: Beginning at a point which is S89°50'18"W 396.00 feet from the Northeast corner of said 40 acre tract, and running thence S00°10'43"W 449.11 feet, thence S89°50'18"W 429.16 feet, thence N00°09'42"W 199.11 feet, thence N00°31'19"W 250.00 feet, thence N89°50'18"E 433.40 feet to the point of beginning containing 4.43 acres more or less, subject to that portion in street right-of-way on the north side of herein described tract, and subject to a 25 foot wide access easement on the east and west side of herein described tract, and subject to that portion in utility easements of record.

**WHEREAS**, the owner has agreed to sell the Property to the City of Springdale for the total sum of \$443,000.00;

**WHEREAS**, the City wishes to purchase the Property upon the receipt of an appraisal showing the value of the Property to be at least \$443,000.00; and

**WHEREAS**, the City plans to use the Property for the relocation and construction of a Fire Station.

**NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL FOR THE CITY OF SPRINGDALE, ARKANSAS** that the Mayor is hereby authorized, upon receipt of an appraisal of the Property showing the value of the Property to be at least \$443,000.00, to execute all documents necessary for the acquisition of the Property in the amount of \$443,000.00, plus associated costs, to be paid from the City's General funds.

**PASSED AND APPROVED** this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST:

\_\_\_\_\_  
Denise Pearce, City Clerk

APPROVED AS TO FORM:

\_\_\_\_\_  
Ernest B. Cate, City Attorney



City of Springdale Zoning Map



April 26, 2021

- Form-Based Code District Overlay

S.E.E.D. Overlay District - Outline

Washington Co. Parcels

Benton Co. Parcels

SCHOOLS

STREAMS

MAIN CHANNEL

TRIBUTARY

LAKES

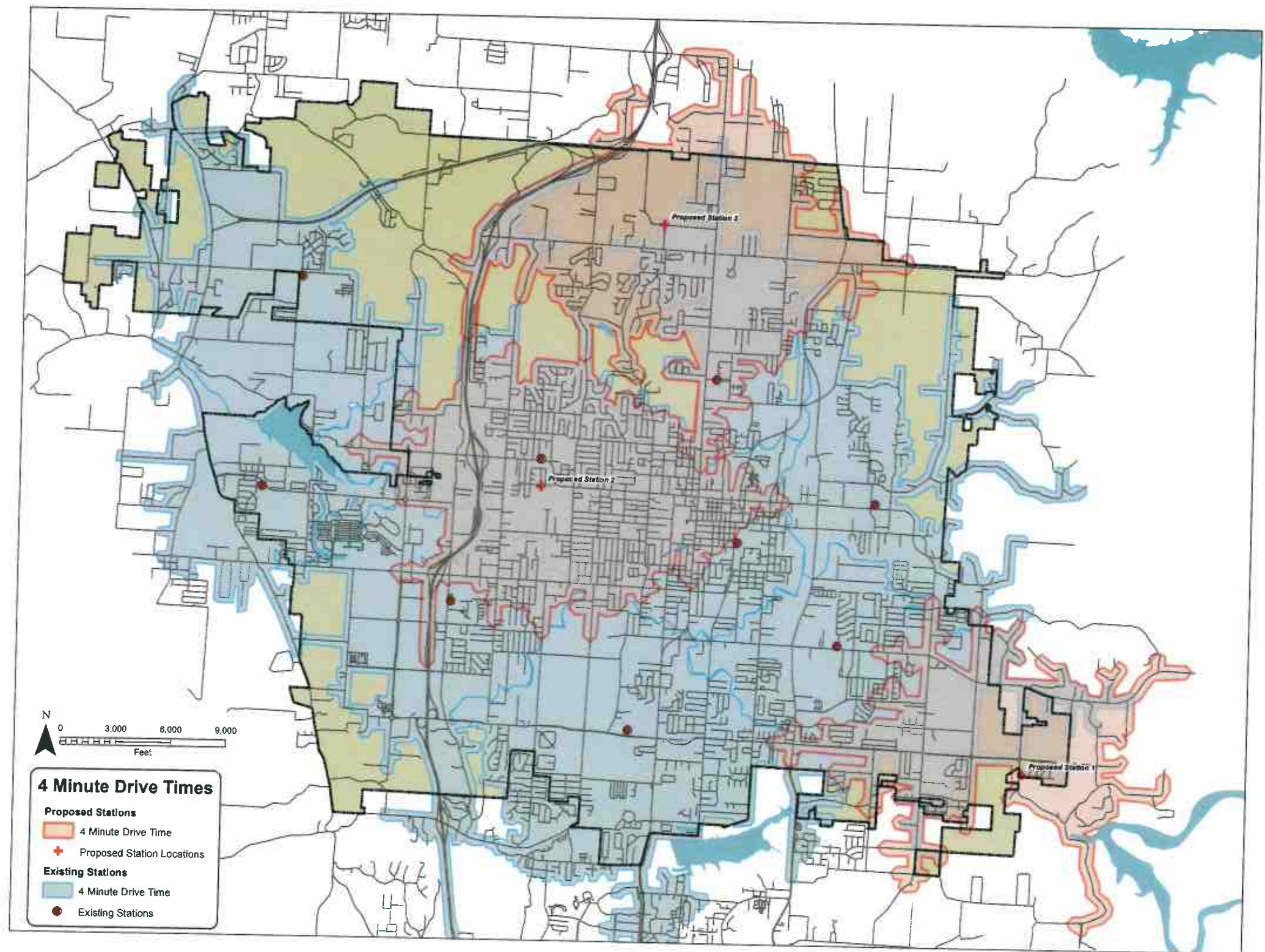
Buildings

RAILROAD
- 1:2,000

0 0.01 0.03 0.06 mi  
0 0.03 0.06 0.11 km

City of Springdale, Clayton Sedberry
- Clayton Sedberry | City of Springdale |
- P.13







RESOLUTION NO. \_\_\_\_\_

**A RESOLUTION AUTHORIZING THE MAYOR AND CITY CLERK TO EXECUTE AN OPTION AGREEMENT FOR THE PURCHASE OF REAL ESTATE OWNED BY THE CITY OF SPRINGDALE.**

**WHEREAS**, the City of Springdale owns the following real property located in the City of Springdale, Arkansas, said land being more particularly described as follows ("the Property"):

Washington County Tax Parcel Nos. 815-28738-210 & 815-28738-230, and as shown on the attached Exhibit "A" which is incorporated herein by reference.

**EXHIBIT "A"**

Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, described as beginning at a point 330 feet West and 200 feet South of the NE Corner of said 40 acre tract, thence South 1120 feet, thence East 165 feet, thence North 1120 feet, thence West 165 feet to the point of beginning, and

Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, described as follows, to-wit: Beginning at a point 500 feet South of the NE Corner of said 40 acre tract, thence South 820 feet, thence West 165 feet, thence North 820 feet, thence East 165 feet to the point of beginning.

And an easement for ingress and egress, described as follows, to-wit: Beginning at the NE Corner of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, run thence South 610 feet, thence West 165 feet to the true point of beginning, thence North 610 feet, thence West 15 feet, thence South 610 feet, thence East 15 feet to the true point of beginning.

**LESS AND EXCEPT:** Part of the SE 1/4 of the SE 1/4 of Section 13, Township 18 North, Range 29 West, described as follows: Beginning at a point 500 feet South of the NE Corner of said 40 acre tract, thence South 110 feet, thence West 165 feet, thence North 110 feet, thence East 165 feet to the point of beginning. **LESS AND EXCEPT:** Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, Washington County, Arkansas, being more particularly described as follows: commencing at a found railroad spike, used as the NE Corner of the SE 1/4 of the SE 1/4; thence North 87 degrees 33 minutes 07 seconds West 165.0 feet; thence South 2 degrees 29 minutes 56 seconds West 203.79 feet to a set 5/8" diameter iron pin and the point of beginning; thence continue South 2 degrees 29 minutes 56 seconds West 120.00 feet to a 5/8" diameter iron pin; thence North 87 degrees 33 minutes 07 seconds West 167.31 feet to a set 5/8" diameter iron pin; thence North 2 degrees 14 minutes 57 seconds East 120.00 feet to a set 5/8" diameter iron pin; thence South 87 degrees 33 minutes 07 seconds East 167.83 feet to the point of beginning, containing 0.46 acres, more or less.

**WHEREAS**, Community Development Corporation of Bentonville/Bella Vista, Inc., and its assigns, wishes to hold an option to purchase the Property;

**WHEREAS**, the City of Springdale is acceptable with the terms of an Option Agreement for the Purchase of Real Estate, which is attached hereto as Exhibit "B" and is incorporated herein by reference, which memorializes the agreement between the parties;

**WHEREAS**, Ark. Code Ann. §14-54-302 empowers and authorizes municipalities to sell, transfer, or dispose of real property it owns, subject to approval by the City Council;

**NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL FOR THE CITY OF SPRINGDALE, ARKANSAS**, that the Mayor and City Clerk of the City of



Springdale, Arkansas, are hereby authorized to execute the attached Option Agreement for the Purchase of Real Estate, attached hereto, with Community Development Corporation of Bentonville/Bella Vista, Inc.

**PASSED AND APPROVED** this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

ATTEST:

\_\_\_\_\_  
Doug Sprouse, Mayor

\_\_\_\_\_  
Denise Pearce, City Clerk

APPROVED:

\_\_\_\_\_  
Ernest B. Cate, City Attorney

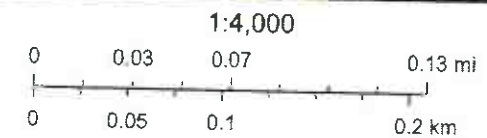


# City of Springdale Zoning Map



April 27, 2021

- |                                     |                    |              |           |
|-------------------------------------|--------------------|--------------|-----------|
| Form-Based Code District Overlay    | Benton Co. Parcels | STREAMS      | LAKES     |
| S.E.E.D. Overlay District - Outline | SCHOOLS            | MAIN CHANNEL | Buildings |
| Washington Co. Parcels              |                    | TRIBUTARY    | RAILROAD  |



City of Springdale, Clayton Sedberry



## OPTION AGREEMENT FOR THE PURCHASE OF REAL ESTATE

THIS OPTION AGREEMENT FOR THE PURCHASE OF REAL PROPERTY (hereinafter "Agreement") is entered on this \_\_\_\_ day of May, 2021, by and between the **City of Springdale** located at 201 N. Spring St., Springdale, AR 72762 (hereinafter "Owner"), and **Community Development Corporation of Bentonville/Bella Vista, Inc. or assigns**, located at 808 N. Main St., Bentonville, AR 72712 (hereinafter "Purchaser").

### WITNESSETH

WHEREAS, Owner is owner of certain parcels of real property, located in Washington County, State of Arkansas, more particularly described on attached Exhibit "A" (hereinafter the "Property");

WHEREAS, Owner is holding said Property and is willing to allow Purchaser to complete various predevelopment activities on said Property if Purchaser so chooses, at Purchaser's expense, more particularly described on attached Exhibit "B";

WHEREAS, Purchaser desires to obtain an option to purchase the Property within a certain period of time (hereinafter "Option"), in order to protect Purchaser's potential investment of time and money;

WHEREAS, Owner is willing to give Purchaser said Option in return for the financial consideration as set forth in this Agreement,

WHEREAS, the parties desire to reduce their agreement to writing.

THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, the parties stipulate and agree as follows:

### AGREEMENT

1. **Property.** Owner represents and warrants that it is the beneficial and rightful owner of the Property, with good and marketable title free and clear of all security interests, mortgages, liens, pledges, charges, claims, or encumbrances of any kind or character.

2. **Granting and Exercising of Option.** Owner grants Purchaser an irrevocable Option to Purchase the Property on the terms and conditions set forth in this Agreement. Purchaser may exercise this Option unilaterally at any time during the term it is offered. Purchaser shall exercise this Option by delivering written notice to Owner's address, as set forth above, with standard U.S. postmarked mail service.

3. **Option Price.** The consideration Purchaser shall pay for the "Option" to purchase the Property, shall be one dollar (\$1.00) (hereinafter "Option Price"). This Option Price shall be non-refundable and payable upon the execution of this Agreement.



4. **Option Term.** The term of this Agreement, and the term during which Owner grants this Option to Purchaser, is for the period beginning upon the execution of this Agreement and expiring on December 31st, 2022.
5. **Purchase Price.** If Purchaser exercises this Option, the price Purchaser shall pay for the Property shall be Two Hundred Sixty Thousand Dollars (\$260,000.00) (hereinafter "Purchase Price"). Said Purchase Price is based on an appraisal obtained by Owner.
6. **Closing.** Closing for said Purchase under this Option shall take place within sixty (60) days of Purchaser giving written notice to Owner, notifying Owner of said intent to exercise said Option (hereinafter "Closing"). However, at no time shall Closing take place later than March 1st, 2023. Therefore, Purchaser shall notify owner of its intent to exercise this Option no later than December 31st, 2022.
7. **Payment of Purchase Price.** Upon Purchaser's exercise of this Option, the Purchaser shall pay for the entire Purchase Price, in cash or its equivalent, at Closing.
8. **Title.** Upon the terms and conditions agreed to and set forth herein, at the Closing, Owner shall convey to Purchaser, by standard warranty deed, with good and indefeasible marketable title in fee simple to the Property free and clear of any and all liens, encumbrances, conditions, easements, restrictions and other conditions, except for the Permitted Exceptions.
9. **Closing Costs.** The parties agree to apportion Closing costs based on standard real estate sales and purchase agreements in the State of Arkansas, including standard apportionment for costs such as property tax, etc.
10. **Title Policy.** If Purchaser so desires, at Closing, Owner shall deliver to Purchaser a standard coverage form of Owner Policy of Title Insurance in the full amount of the Purchase Price, insuring Purchaser's indefeasible fee simple title to the Property subject only to the Permitted Exceptions and taxes for the year of Closing and subsequent assessments for prior years due to change in land usage or ownership.
11. **Liens Against Property.** Owner and Purchaser hereby agree that there shall be no liens placed upon the Property, by either Owner or Purchaser, during the term of this Agreement and the Property transferred to Purchaser upon the exercise of this Option shall be delivered free of all liens and/or encumbrances of any kind. Additionally, Purchaser shall indemnify and hold harmless the Owner against and from any and all liens, mechanics or otherwise that may be place upon this Property related either directly or indirectly to Purchaser's actions, or its agents or assigns.
12. **Liability for Purchaser's Potential Improvements.** Owner shall not be liable for any damage, either to person or property, sustained due to the operations or actions of Purchaser in its improvement of the property in any tangible or intangible manner. The parties agree that Purchaser shall have no duty or obligation of any kind to improve, upkeep or repair the Property. However, Purchaser shall not negatively impact the value of the Property, below the Purchase Price, due to the happening of any act of Purchaser, its agents, servants or employees, or shall be liable to Owner for said damage.
13. **Option Assignable.** Owner agrees that Purchaser may assign this Option on or before Closing.



14. **Miscellaneous**

A. **Entire Agreement.** This Agreement embodies the entire agreement between the parties and cannot be varied except by the written agreement of the parties.

B. **Survival.** All promises, representations and warranties intended to extend beyond the closing date shall survive the Closing.

C. **Notices.** Any notice required or permitted to be delivered hereunder shall be deemed to be delivered (a) when delivered, if personally delivered or by an overnight or other courier service, or (b) whether or not actually received, when deposited in the United States mail, postage prepaid, certified mail, return receipt requested, addressed to Seller or Purchaser, as the case may be, addressed as follows:

Seller:

City of Springdale  
Attn.: Mayor Doug Sprouse  
201 N. Spring St.  
Springdale, AR 72762

Purchaser:

CDC Bentonville/Bella Vista Inc.  
808 N. Main St. #1  
Bentonville, AR 72712

Such addresses may be changed from time to time by either party by providing written notice in the manner set forth above.

D. **Successors and Assigns.** All of the terms and conditions of this Agreement are hereby made binding on the successors and permitted assigns of both parties hereto.

E. **Governing Law.** This Agreement shall be governed by and construed in accordance with the laws of the State of Arkansas, and venue for any disputes shall be in Benton County.

F. **Attorneys' Fees.** In the event that a legal action is brought to enforce the terms of this Agreement, the prevailing party shall be entitled to collect its costs of court, including reasonable attorneys' fees.

G. **Severability.** If any provision of this Agreement is held to be illegal, invalid or unenforceable under present or future laws, such provision shall be fully severable, and this Agreement shall be construed and enforced as if such illegal, invalid or unenforceable provision had never comprised a part of this Agreement, and the remaining provisions of this Agreement shall remain in full force and effect and not be affected by the illegal, invalid or unenforceable provision or by its severance from this Agreement, provided that both parties may still effectively realize the complete benefit of the transaction contemplated hereby.

H. **Amendments.** No modification or amendment of this Agreement shall be effective unless made in writing and executed by both Owner and Purchaser. In the event any approval or consent is required pursuant to any provision of this Agreement, such approval or consent shall be deemed given only if it is in writing, executed by the party whose approval or consent is required.



IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the date first written above.

PURCHASER

Community Development Corporation of  
Bentonville/Bella Vista, Inc.

By: \_\_\_\_\_

The duly authorized and acting Mayor of the City of Springdale, Arkansas, Doug Sprouse, and attested by its duly authorized and acting City Clerk of the City of Springdale, both of whom are authorized to bind the Owner to this Agreement.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST: \_\_\_\_\_  
Denise Pearce, City Clerk



**ACKNOWLEDGMENT**

STATE OF ARKANSAS  
COUNTY OF WASHINGTON

)SS  
)

On this the \_\_\_\_\_ day of \_\_\_\_\_, 2021, before me, a Notary Public, qualified and acting, within and for the said County and State, appeared in person the within named \_\_\_\_\_ (being the person authorized by Purchaser herein to execute such instrument), to me personally known and who stated he/she was the \_\_\_\_\_ of Community Development Corporation of Bentonville/Bella Vista, Inc., and was duly authorized in his capacity to execute the foregoing instrument for and in the name and behalf of said Purchaser, and further stated and acknowledged that he had so signed, executed and delivered foregoing instrument for the consideration, uses and purposes therein mentioned and set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

My Commission Expires:

\_\_\_\_\_

\_\_\_\_\_  
Notary Public

**ACKNOWLEDGMENT**

STATE OF ARKANSAS  
COUNTY OF WASHINGTON

)SS  
)

BE IT REMEMBERED, that on this day, came before the undersigned, a Notary Public, within and for the County aforesaid, duly commissioned and acting Doug Sprouse and Denise Pearce, to me well known as the Mayor and City Clerk for the City of Springdale, the Seller in the foregoing Agreement, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

Witness my hand and seal as such Notary Public this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
My Commission Expires

\_\_\_\_\_  
Notary Public



### Exhibit "A"

Washington County Parcel #s 815-28738-210 & 815-28738-230

#### EXHIBIT "A"

Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, described as beginning at a point 330 feet West and 200 feet South of the NE Corner of said 40 acre tract, thence South 1120 feet, thence East 165 feet, thence North 1120 feet, thence West 165 feet to the point of beginning, and

Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, described as follows, to-wit: Beginning at a point 500 feet South of the NE Corner of said 40 acre tract, thence South 820 feet, thence West 165 feet, thence North 820 feet, thence East 165 feet to the point of beginning.

And an easement for ingress and egress, described as follows, to-wit: Beginning at the NE Corner of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, run thence South 610 feet, thence West 165 feet to the true point of beginning, thence North 610 feet, thence West 15 feet, thence South 610 feet, thence East 15 feet to the true point of beginning.

LESS AND EXCEPT: Part of the SE 1/4 of the SE 1/4 of Section 13, Township 18 North, Range 29 West, described as follows: Beginning at a point 500 feet South of the NE Corner of said 40 acre tract, thence South 110 feet, thence West 165 feet, thence North 110 feet, thence East 165 feet to the point of beginning. LESS AND EXCEPT: Part of the SE 1/4 of the SE 1/4 of Section 31, Township 18 North, Range 29 West, Washington County, Arkansas, being more particularly described as follows: commencing at a found railroad spike, used as the NE Corner of the SE 1/4 of the SE 1/4; thence North 87 degrees 33 minutes 07 seconds West 165.0 feet; thence South 2 degrees 29 minutes 56 seconds West 203.79 feet to a set 5/8" diameter iron pin and the point of beginning; thence continue South 2 degrees 29 minutes 56 seconds West 120.00 feet to a 5/8" diameter iron pin; thence North 87 degrees 33 minutes 07 seconds West 167.31 feet to a set 5/8" diameter iron pin; thence North 2 degrees 14 minutes 57 seconds East 120.00 feet to a set 5/8" diameter iron pin; thence South 87 degrees 33 minutes 07 seconds East 167.83 feet to the point of beginning, containing 0.46 acres, more or less.



## **Exhibit “B”**

Anticipated pre-development activities:

- Financing commitment
- Appraisal
- Re-zoning
- Market Study
- Environmental clearance
- Site engineering
- Architectural design



RESOLUTION NO. \_\_\_\_\_

**A RESOLUTION AUTHORIZING THE MAYOR AND CITY CLERK TO EXECUTE A RIGHT OF FIRST REFUSAL AGREEMENT ON PROPERTY OWNED BY THE CITY OF SPRINGDALE.**

**WHEREAS**, the City of Springdale owns the following real property located in the City of Springdale, Arkansas, said land being more particularly described as follows ("the Property"):

6476 Downum Road, Tax Parcel No. 21-00167-504, approximately 1.00 acre, more or less, Benton County, Springdale, Arkansas, and as shown on the attached survey which is incorporated herein by reference as Exhibit "A".

**WHEREAS**, Britnee Stearman wishes to hold a right of first refusal to purchase the Property should the City of Springdale receive a bona fide offer on the Property;

**WHEREAS**, Britnee Stearman is acceptable with the terms of a Right of First Refusal Agreement, which is attached hereto as Exhibit "B" and is incorporated herein by reference;

**WHEREAS**, Ark. Code Ann. §14-54-302 empowers and authorizes municipalities to sell real property it owns, subject to approval by the City Council;

**WHEREAS**, it is reasonable to grant a right of first refusal to Britnee Stearman, as she is desirous to acquire the Property;

**NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL FOR THE CITY OF SPRINGDALE, ARKANSAS**, that the Mayor and City Clerk of the City of Springdale, Arkansas, are hereby authorized to execute the attached Right of First Refusal Agreement, attached hereto, with Britnee Stearman.

**PASSED AND APPROVED** this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST:

\_\_\_\_\_  
Denise Pearce, City Clerk

APPROVED:

\_\_\_\_\_  
Ernest B. Cate, City Attorney



# PLAT OF SURVEY

TOTAL ACREAGE  
PARCELS  
#21-00167-542  
#21-00167-504  
2.04 ACRES +/-

PARCEL #21-00167-504  
1.00 ACRES +/-

PARCEL #21-00167-542  
1.04 ACRES +/-

DATE OF SURVEY

DATE OF RECORD

STATIONING SYSTEM  
UTM ZONE 18Q UTM COORDINATES  
EASTING 650,000.000  
NORTHING 6,500,000.000  
ELEVATION 100.000

PROJECTION SYSTEM

UNIT OF MEASURE  
FEET  
METERS  
METERS PER FOOT  
FEET PER METER

THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS. THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS.

THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS. THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS.

0' 30' 60' 90'



IN WITNESS WHEREOF, I have hereunto set my hand and seal at Tallahassee, Florida, this 1st day of January, 2010.

VICINITY MAP



THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS. THE SURVEYOR HAS BEEN ADVISED THAT THE PROPERTY IS NOT SUBJECT TO ANY EASEMENTS, RIGHTS OF WAY, OR OTHER INTERESTS.

JAMES A. PRICHARD  
REGISTERED  
PROFESSIONAL LAND SURVEYOR  
STATE OF FLORIDA  
LICENSE NO. 12345

**Bates & Associates, Inc.**  
Engineers - Surveyors - Landscapers  
10000 N. W. 10th Ave., Suite 100  
Tallahassee, FL 32304  
Phone: (904) 833-1234  
Fax: (904) 833-5678  
www.batesandassociates.com



**LEGEND**  
--- Boundary Line  
--- Easement Line  
--- Right of Way Line  
--- Survey Line  
--- Existing Building  
--- Proposed Building  
--- Existing Road  
--- Proposed Road  
--- Existing Waterway  
--- Proposed Waterway  
--- Existing Utility  
--- Proposed Utility  
--- Existing Fence  
--- Proposed Fence  
--- Existing Tree  
--- Proposed Tree  
--- Existing Plant  
--- Proposed Plant  
--- Existing Structure  
--- Proposed Structure  
--- Existing Feature  
--- Proposed Feature





**RIGHT OF FIRST REFUSAL TO PURCHASE REAL ESTATE**

This Right of First Refusal to Purchase Real Estate is made on this \_\_\_\_\_ day of May, 2021, by and between the City of Springdale, Arkansas, hereinafter referred to as the "SELLER" and Britnee Stearman, and her assigns, hereinafter referred to as the "PURCHASER".

WHEREAS, Purchaser desires to obtain a right of first refusal or first option to purchase certain real estate owned by Seller; and

WHEREAS, Seller agrees to grant Purchaser a right of first refusal or first option to purchase real estate pursuant to the terms of this agreement and city council approval; and

NOW, FOR AND IN CONSIDERATION OF \$10.00 and other good and valuable considerations, the receipt and sufficiency of which is hereby acknowledged, it is agreed as follows:

I. GRANT OF FIRST OPTION: The Seller does hereby grant unto the Purchaser the exclusive right, during the term of this agreement, of first refusal and first option to purchase, upon the terms and conditions hereinafter set forth, Seller's property situated at 6476 Downum Road, Tax Parcel No. 21-00167-504, approximately 1.00 acre, more or less, Benton County, Springdale, Arkansas, and as shown on the attached survey which is incorporated herein by reference, together with all improvements located thereon.

II. EXERCISE OF FIRST OPTION: This right of first refusal or first option to purchase may only be exercised by Purchaser within five (5) calendar days from notification by Seller that Seller desires to sell the subject property. Seller is obligated to provide such notice to Purchaser prior to offering the subject property to a third party.

III. TERMS OF PURCHASE: In the event Seller elects to sell and Purchaser desires to exercise the first refusal rights granted under the terms of this agreement, the terms of purchase shall be as follows:



a) Listing prices at the time of sale; or

b) The terms of a bona fide offer to purchase the property received by Seller and Seller wishes to accept said offer.

IV. DECLINATION OF RIGHT: If Purchaser declines to exercise this right of first refusal after being notified pursuant to Section II herein, Seller is free to accept any bona fide offer it deems reasonable.

V. CONTRACT: Within five (5) calendar days after the Purchaser has exercised this right of first refusal, Seller shall deliver to Purchaser a Contract for Purchase of Real Property. Upon receipt of said Contract for Purchase of Real Property, Purchaser shall have five (5) calendar days to execute said Contract and return it to Seller.

VI. CLOSING AND EXPENSES OF SALE: Closing shall take place within thirty (30) days of execution of the Contract for Purchase of Real Property. Purchaser and Seller agree that Seller shall order an owner's title policy for the subject property from a title company authorized to do business in the State of Arkansas in order to ensure a timely closing of subject property and Seller shall be responsible for costs associated with the purchase of said owner's title policy. The parties shall otherwise each pay their own ordinary closing costs unless otherwise indicated.

VII. POSSESSION: Purchaser shall be entitled to possession of the property at closing.

VIII. TAXES: Taxes, if any, shall be prorated as of the date of closing.

IX. GOVERNING LAW: This agreement shall be governed by the laws of the State of Arkansas.



IN WITNESS WHEREOF, the parties have hereunto set their hands and seals as duly authorized and acting representatives of their respective parties to this contract, this \_\_\_\_ day of \_\_\_\_\_, 2021.

PURCHASER

By: \_\_\_\_\_

The duly authorized and acting Mayor of the City of Springdale, Arkansas, Doug Sprouse, and attested by its duly authorized and acting City Clerk of the City of Springdale, both of whom are authorized to bind the Seller to this Agreement.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST: \_\_\_\_\_  
Denise Pearce, City Clerk



STATE OF ARKANSAS       )  
COUNTY OF WASHINGTON)

ACKNOWLEDGMENT

BE IT REMEMBERED, that on this day, came before the undersigned, a Notary Public, within and for the County aforesaid, duly commissioned and acting Britnee Stearman, to me well known as the Purchaser in the foregoing document, and stated that she had executed the same for the consideration and purposes therein mentioned and set forth.

Witness my hand and seal as such Notary Public this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
My Commission Expires

\_\_\_\_\_  
Notary Public

STATE OF ARKANSAS       )  
COUNTY OF WASHINGTON)

ACKNOWLEDGMENT

BE IT REMEMBERED, that on this day, came before the undersigned, a Notary Public, within and for the County aforesaid, duly commissioned and acting Doug Sprouse and Denise Pearce, to me well known as the Mayor and City Clerk for the City of Springdale, the Seller in the foregoing Agreement, and stated that they had executed the same for the consideration and purposes therein mentioned and set forth.

Witness my hand and seal as such Notary Public this \_\_\_\_\_ day of \_\_\_\_\_, 2021.

\_\_\_\_\_  
My Commission Expires

\_\_\_\_\_  
Notary Public



**RESOLUTION NO. \_\_\_\_\_**

**A RESOLUTION AUTHORIZING THE EXECUTION  
OF A CONSTRUCTION CONTRACT AND A  
CHANGE ORDER FOR PARK STREET  
PROJECT NO 18BPS13**

**WHEREAS**, sealed bids were received on March 16, 2021 at 2:00 p.m. for two intersections on Park Street; and

**WHEREAS**, Crossland Heavy Contractors was the low bidder for this project at \$3,037,507.65; and

**WHEREAS**, the low bid exceeded our expectations and negotiations with the contractor resulted in a proposed cost reduction of \$232,816.00.

**NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL  
FOR THE CITY OF SPRINGDALE, ARKANSAS, that**

**Section 1.** The Mayor and City Clerk are hereby authorized to execute a contract with Crossland Heavy Contractors for construction of two intersections on Park Street for \$3,037,507.65.

**Section 2.** The Mayor is hereby authorized to execute change order number #1 to this contract.

**Section 3.** The Mayor is authorized to approve additional construction change orders as long as the cumulative total of the additional change orders does not exceed 10% of the original contract price.

**PASSED AND APPROVED** this 11<sup>th</sup> day of May, 2021.

\_\_\_\_\_  
Doug Sprouse, Mayor

ATTEST:

\_\_\_\_\_  
Denise Pearce, City Clerk

APPROVED AS TO FORM:

\_\_\_\_\_  
Ernest B. Cate, City Attorney





2649 E. Joyce Blvd.  
Suite 400  
Fayetteville, AR 72703  
TEL 479.527.9100  
FAX 479.527.9101  
www.GarverUSA.com

### Construction Contract Change Order

**Project:**  
Park Street Intersections Improvements (18BPS13)  
Springdale, Arkansas  
Garver Job No. 19T21050

**Change Order No.** 1

**Date Prepared:** April 20, 2021  
**Prepared by:** Jeff Webb, PE

**Owner:**  
City of Springdale  
269 E. Randall Wobbe Ln.  
Springdale, AR 72764

**Contractor:**  
Crossland Heavy Contractors  
501 S. East Ave.  
Columbus, KS 66725

**Description of Work Included in Contract**  
scope of work, paraphrased

#### Changes and Reasons Ordered (List Individual Changes as: A, B, C, D, etc.)

- A. Eliminate light pole fixtures and electrical conductors (wire). ( Bid Items 31 & 103)  
Light pole foundations/anchor bolts and conduit will still be installed along with pull rope.
- B. Switch stamped concrete at Caudle/Park Intersection to plain concrete on both 6" & 8" thicknesses (Bid Items 42 & 45)

Attachments: VE Pricing Email dated 4-7-2021

Contract Changes	Bid Item No.	Bid Item Description	Unit of Measure	Original Contract Quantity	Contract Unit Price	Revised Estimated Quantity	Revised Unit Price	Original Estimated Cost	Revised Estimated Cost
A.	31	Street Lighting (Park/Caudle/Powell)	LS	1	\$195,000.00	1	\$108,360.00	\$195,000.00	\$108,360.00
B.	42	6" U.T. Stamped Colored Concrete (Truck Apron)	SY	898	\$139.00	0	\$139.00	\$124,822.00	\$0.00
B.	45	8" U.T. Stamped Colored Concrete (Splitter Islands)	SY	161	\$174.00	0	\$174.00	\$28,014.00	\$0.00
A.	103	Street Lighting (Park/Emma/Berry)	LS	1	\$149,000.00	1	\$84,020.00	\$149,000.00	\$84,020.00
B.	CO-1.1	6" U.T. Truck Apron Concrete	SY	0	\$0.00	898	\$64.00	\$0.00	\$57,472.00
B.	CO-1.2	8" U.T. Splitter Island Concrete	SY	0	\$0.00	161	\$88.00	\$0.00	\$14,168.00
								\$0.00	\$0.00

**Summation of Cost** \$496,836.00  
**Net Cost for this Change Order** (\$232,816.00)

#### Estimated Project Cost

Original Contract Amount \$3,037,507.65  
This Change Order (\$232,816.00)  
New Contract Amount \$2,804,691.65

#### Time Change

Original Contract Start Date TBD  
Original Contract Time (calendar days) 300  
Additional Calendar Days granted by this Change Order 0  
New Contract Time (calendar days) 300  
Suspended Time  
New Construction Completion Date TBD

THIS AGREEMENT IS SUBJECT TO ALL ORIGINAL CONTRACT PROVISIONS AND PREVIOUS CHANGE ORDERS

ISSUED FOR REASONS  
INDICATED ABOVE  
Engineer: Garver

Engineer's Signature

Project Manager

4-20-2021  
Date

ACCEPTED BY  
CONTRACTOR  
Crossland Heavy Contractors

Daniel Thompson

Digitally signed by Daniel Thompson  
DN: cn=Daniel Thompson, o=Crossland Heavy Contractors, c=US  
Date: 2021.04.20 16:25:00 -0500

Vice President

04/20/2021  
Date

APPROVED BY  
OWNER  
City of Springdale

Owner's Signature

Title

Date



---

**From:** Wyman Morgan

**From:** Dan Thompson <[dthompson@heavycontractors.com](mailto:dthompson@heavycontractors.com)>

**Sent:** Wednesday, April 7, 2021 4:47 PM

**To:** Webb, D. Jeffrey <[DJWebb@GarverUSA.com](mailto:DJWebb@GarverUSA.com)>

**Subject:** Park Street Intersection - Springdale

Good afternoon Jeff,

Sorry it took me this long to get this potential cost savings priced and sent over to you.

We have proposed 3 VE options for consideration:

1. Eliminate Light Pole fixtures & wire ( Bid Items 31 & 103) -  
Net Deduct \$151,620
  - a. We would still install the light pole foundations and run all conduit.
  - b. We would not purchase or install any light poles or pull any wire.
2. Switch Stamped concrete at Claudle to plain concrete on both 6" & 8" thicknesses (Bid Items 42 & 45)  
Net Deduct \$81,196
  - a. 6" concrete would be at unit price of \$64/SY matching unit price on Bid Item 32 quantity of 898 SY
  - b. 8" concrete priced at \$88/SY quantity of 161 SY
3. Closing Emma/Park Intersection for utility installs and total intersection reconstruct. 3-4 month duration  
Net Deduct \$92,769
  - a. MOT of traffic gets easier
  - b. Asphalt sub has fewer mobilizations
  - c. Increased efficiencies during construction.
  - d. NOTE: Water & Sewer work will be imperative to meet this schedule, and most likely we will Encounter some unknowns. We will need answers ASAP to be able to meet this construction window.

I realize that closing Emma is or could be seen very negatively by the city and rightfully so. But there is some definite cost savings there for us. I would propose to do this work over the summer starting as soon as school was out or shortly thereafter. I also realize that the city has the Rodeo of the Ozarks parade and involves this intersection being opened. That said, we could make temporary plans for this event and coordinate our work to have little to no effect on the parade. Any temporary improvements costs, depending on what all that involves would be priced and come off the net deduct for closing this intersection.

**Total potential deduct is \$325,585 for a  
grand total of \$2,712,661.**

Please let me know if you have any questions, and I look forward to hearing back from you or the city.



Thanks,

**Dan Thompson**

Arkansas Division Manager

705 S. Lincoln

Lowell, AR 72745

t: 479-347-7960

c: 479-366-1637





2049 E. Joyce Blvd.  
Suite 400  
Fayetteville, AR 72703

TEL 479.527.9100  
FAX 479.527.9101

[www.GarverUSA.com](http://www.GarverUSA.com)

April 20, 2021

Ryan Carr, PE, CFM  
Deputy Director of Engineering Operations  
City of Springdale  
269 E. Randall Wobbe Ln.  
Springdale, AR 72764

Re: City of Springdale  
Park Street Intersections Improvements  
City Project No. 18BPS13  
Recommendation of Award

Dear Ryan:

Bids were received for the "Park Street Intersections Improvements" in the online bid interface at 2:00 p.m. on March 16, 2021. The bids have been checked for accuracy and for compliance with the contract documents. A tabulation of the bids received is enclosed with this letter.

A total of 2 bids were received on the project. Crossland Heavy Contractors submitted the low bid for the project in the amount of \$3,037,507.65. The Engineer's Opinion of Probable Cost was \$2,573,150.50.

Following the opening of the bid, Garver worked with Crossland Heavy Contractors to evaluate value engineering (VE) items for the project. Crossland Heavy Contractors provided the attached email with three VE items as a response on April 7, 2021. Out of the three items presented the following two items will be incorporated into the Contract with a subsequent Change Order:

VE Item #1: Eliminate light pole fixtures and wire - Net Deduct of \$151,620.00

VE Item #2: Switch stamped colored concrete at the Park/Caudle intersection with plain concrete -- Net Deduct of \$81,196.00

Total value of VE Items: -\$232,816.00

New Contract Value: \$2,804,691.65

We believe that the bid submitted by Crossland Heavy Contractors along with the accepted VE Items represents a good value for the City of Springdale. We recommend that the construction contract for the "Park Street Intersections Improvements" be awarded to Crossland Heavy Contractors.



Mr. Carr  
April 20, 2021  
Page 2 of 2

Please call me if you have any questions.

Sincerely,

GARVER, LLC



Digitally signed by D.  
Jeffrey Webb  
Date: 2021.04.20  
15:44:09-05'00'

D. Jeffrey Webb, P.E.  
Project Manager

Attachments: Bid Tabulation  
VE Items Proposal Email  
Change Order No. 1

L:\2019\19T21050 - Park Street Intersections\Bidding\Recommendation of Award\Park Street Intersection Recommendation to Award.docm



CITY OF SPRINGDALE PARK STREET INTERSECTIONS SUMMARY OF BIDS		ENGINEER'S ESTIMATE	CROSSLAND HEAVY	APAC CENTRAL
Bid Schedule 1	Park Street and Caudle Avenue Intersection Roadway, Drainage, And Lighting	\$ 1,080,267.00	\$ 1,203,591.00	\$ 1,544,278.89
Bid Schedule 2	Emma Avenue and Park Street Intersection Roadway, Drainage, And Lighting	\$ 1,057,043.50	\$ 1,243,974.45	\$ 1,489,381.72
Bid Schedule 3	Park Street and Caudle Avenue Water and Sewer Relocations	\$ 247,250.00	\$ 353,380.00	\$ 225,004.68
Bid Schedule 4	Emma Avenue and Park Street Water and Sewer Relocations	\$ 188,590.00	\$ 236,562.20	\$ 183,840.25
TOTAL:		\$ 2,573,150.50	\$ 3,037,507.65	\$ 3,442,505.54



CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 1  
PARK STREET AND CAUDLE AVENUE INTERSECTION  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
1	111	Roadway Construction Control	LS	1	\$10,000.00	\$10,000.00	\$55,000.00	\$55,000.00	\$40,000.00	\$40,000.00
2	201	Clearing and Grubbing	LS	1	\$40,000.00	\$40,000.00	\$70,000.00	\$70,000.00	\$60,000.00	\$60,000.00
3	202	Undercut and Backfill	CY	3,000	\$30.00	\$90,000.00	\$25.00	\$75,000.00	\$36.00	\$108,000.00
4	202	Unclassified Excavation (Plan Quantity)	CY	2,028	\$15.00	\$30,390.00	\$14.00	\$28,364.00	\$18.00	\$36,468.00
5	202	Embankment (Plan Quantity)	CY	116	\$20.00	\$2,360.00	\$18.00	\$2,088.00	\$40.00	\$4,720.00
6	203	Subgrade Preparation (Plan Quantity)	SY	4,530	\$4.00	\$18,120.00	\$1.80	\$8,154.00	\$2.75	\$12,457.50
7	204	Curb Backfill and Grading	Sta	19	\$1,000.00	\$19,000.00	\$850.00	\$16,150.00	\$1,200.00	\$22,800.00
8	204	4" Topsoil Placement (Yard Areas)	SY	3,388	\$3.00	\$10,164.00	\$3.75	\$12,705.00	\$8.00	\$27,104.00
9	401	6" Aggregate Base Course	SY	4,530	\$10.00	\$45,300.00	\$16.00	\$72,480.00	\$13.00	\$58,890.00
10	403	Asphalt Concrete Hot Mix Surface Course	Ton	365	\$120.00	\$43,800.00	\$140.00	\$51,100.00	\$110.00	\$40,150.00
11	403	Asphalt Concrete Hot Mix Binder Course	Ton	620	\$100.00	\$62,000.00	\$119.00	\$73,780.00	\$95.00	\$58,900.00
12	405	Asphalt Concrete Patching for Maintenance of Traffic	Ton	25	\$200.00	\$5,000.00	\$440.00	\$11,000.00	\$301.67	\$7,541.75
13	501	Concrete Curb and Gutter (Type - A)	LF	1,334	\$20.00	\$26,680.00	\$16.50	\$22,079.00	\$30.00	\$40,020.00
14	501	Concrete Curb and Gutter (Type - B)	LF	532	\$20.00	\$10,640.00	\$21.50	\$11,438.00	\$50.00	\$26,600.00
15	502	4" Thick Concrete Sidewalk	SY	282	\$57.00	\$16,074.00	\$58.00	\$16,356.00	\$55.00	\$15,510.00
16	503	Concrete Driveway	SY	179	\$75.00	\$13,425.00	\$84.00	\$15,036.00	\$80.00	\$14,320.00
17	503	Asphalt / Concrete Driveway Removal	SY	725	\$17.00	\$12,325.00	\$13.00	\$9,425.00	\$15.00	\$10,875.00
18	505	Seeding	AC	1	\$3,500.00	\$3,500.00	\$4,000.00	\$4,000.00	\$4,200.00	\$4,200.00
19	505	Sodding	SY	3,388	\$4.50	\$15,246.00	\$4.50	\$15,246.00	\$5.00	\$16,940.00
20	505	Additional Watering	MG	100	\$45.00	\$4,500.00	\$50.00	\$5,000.00	\$58.00	\$5,800.00
21	507	6" Striping (Thermoplastic)	LF	2,272	\$2.50	\$5,680.00	\$4.25	\$9,658.00	\$3.00	\$6,816.00
22	507	12" Striping (Thermoplastic)	LF	433	\$15.00	\$6,495.00	\$6.00	\$2,598.00	\$15.00	\$6,495.00
23	507	Pavement Symbols (Thermoplastic)	EA	22	\$350.00	\$7,700.00	\$350.00	\$7,700.00	\$500.00	\$11,000.00
24	509	Erosion Control	LS	1	\$15,000.00	\$15,000.00	\$6,000.00	\$6,000.00	\$5,000.00	\$5,000.00
25	510	Traffic Control	LS	1	\$10,000.00	\$10,000.00	\$28,000.00	\$28,000.00	\$70,000.00	\$70,000.00
26	511	Mobilization (not to exceed 5% of contract price)	LS	1	\$50,000.00	\$50,000.00	\$50,500.00	\$50,500.00	\$70,000.00	\$70,000.00
27	513	Cast-in-Place Tactile Panel	SF	407	\$35.00	\$14,245.00	\$15.00	\$6,105.00	\$21.00	\$8,547.00
28	513	Handicap Ramp Concrete	SY	174	\$75.00	\$13,050.00	\$70.00	\$12,180.00	\$70.00	\$12,180.00
29	516	Cold Milling Asphalt Pavement	SY	407	\$6.00	\$2,442.00	\$20.00	\$8,140.00	\$17.00	\$6,919.00
30	707	12" Non-Metallic Conduit (Irrigation Sleeves)	LF	32	\$15.00	\$480.00	\$10.00	\$320.00	\$10.00	\$320.00
31	SP-3	Street Lighting (Park/Caudle/Powell)	LS	1	\$162,000.00	\$162,000.00	\$195,000.00	\$195,000.00	\$280,447.64	\$280,447.64
32	SP-4	6" Thick Concrete Trail	SY	313	\$62.00	\$19,406.00	\$64.00	\$20,032.00	\$80.00	\$25,040.00
33	SP-5	Modular Block Retaining Wall	SF	50	\$60.00	\$3,000.00	\$30.00	\$1,500.00	\$30.00	\$1,500.00
34	SP-6	Remove, Salvage, and Reinstall Existing Decorative Fence	LF	152	\$60.00	\$9,120.00	\$46.00	\$6,992.00	\$60.00	\$9,120.00
35	SP-7	Furnish and Install Sign with Standard Support	EA	23	\$750.00	\$17,250.00	\$385.00	\$8,855.00	\$600.00	\$13,800.00
36	SP-7	Remove, Salvage, and Reinstall Sign with New Support	EA	2	\$250.00	\$500.00	\$194.00	\$388.00	\$650.00	\$1,300.00





CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 1  
PARK STREET AND CAUDLE AVENUE INTERSECTION  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
37	SP-8	Retaining Wall Integral with 6" Thick Sidewalk	LF	51	\$240.00	\$12,240.00	\$195.00	\$9,945.00	\$350.00	\$17,850.00
38	SP-11	Bike Repair Station, Installed	EA	1	\$4,800.00	\$4,800.00	\$2,900.00	\$2,900.00	\$8,000.00	\$8,000.00
39	SP-11	Benches, Installed	EA	1	\$2,400.00	\$2,400.00	\$2,500.00	\$2,500.00	\$8,000.00	\$8,000.00
40	SP-11	Water Fountain, Installed	EA	1	\$12,000.00	\$12,000.00	\$11,000.00	\$11,000.00	\$20,000.00	\$20,000.00
41	SP-11	Waste Receptacle, Installed	EA	1	\$1,200.00	\$1,200.00	\$500.00	\$500.00	\$5,000.00	\$5,000.00
42	SP-12	6" U.T. Stamped Colored Concrete (Truck Apron)	SY	898	\$100.00	\$89,800.00	\$139.00	\$124,822.00	\$200.00	\$179,600.00
43	SP-12	8" U.T. Stamped Colored Concrete (Spitter Islands)	SY	161	\$110.00	\$17,710.00	\$174.00	\$28,014.00	\$200.00	\$32,200.00
44	SP-13	Building Demolition and Disposal	LS	1	\$35,000.00	\$35,000.00	\$15,000.00	\$15,000.00	\$40,000.00	\$40,000.00
45	SP-14	Concrete Speed Table	EA	2	\$12,000.00	\$24,000.00	\$8,500.00	\$17,000.00	\$5,500.00	\$11,000.00
46	SP-16	Rectangular Rapid Flashing Beacon (RRFB)	EA	4	\$13,250.00	\$53,000.00	\$8,400.00	\$33,600.00	\$12,000.00	\$48,000.00
47	SP-19	Concrete Curb (Type 1 Special) (1'-0")	LF	202	\$25.00	\$5,050.00	\$27.00	\$5,454.00	\$40.00	\$8,080.00
48	SP-19	Concrete Curb (Type 2 Special) (1'-0")	LF	247	\$25.00	\$6,175.00	\$27.00	\$6,669.00	\$40.00	\$9,880.00
49	SP-20	Remove, Salvage, and Reinstall Business Sign	EA	1	\$2,000.00	\$2,000.00	\$7,000.00	\$7,000.00	\$3,500.00	\$3,500.00
TOTALS						\$1,080,267.00		\$1,203,591.00		\$1,544,278.89





CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 2  
EMMA AVENUE AND PARK STREET INTERSECTION  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
50	111	Roadway Construction Control	LS	1	\$5,000.00	\$5,000.00				
51	112	Trench and Excavation Safety Systems	LS	1	\$2,000.00	\$2,000.00				
52	201	Clearing and Grubbing	LS	1	\$40,000.00	\$40,000.00				
53	202	Undercut and Backfill	CY	1,900	\$30.00	\$57,000.00				
54	202	Rock Excavation	CY	100	\$200.00	\$20,000.00				
55	202	Unclassified Excavation (Plan Quantity)	CY	1,134	\$15.00	\$17,010.00				
56	202	Embankment (Plan Quantity)	CY	20	\$20.00	\$400.00				
57	203	Subgrade Preparation (Plan Quantity)	SY	2,769	\$4.00	\$11,076.00				
58	204	Curb Backfill and Grading	Sla	18	\$1,000.00	\$18,000.00				
59	204	4" Topsoil Placement (Yard Areas)	SY	714	\$3.00	\$2,142.00				
60	301	18" Class III R.C. Pipe, Within Roadway	LF	175	\$100.00	\$17,500.00				
61	301	36" Class III R.C. Pipe, Within Roadway	LF	168	\$160.00	\$26,880.00				
62	301	23" X 14" Class III Elliptical R.C. Pipe, Within Roadway	LF	33	\$125.00	\$4,125.00				
63	301	30" X 19" Class III Elliptical R.C. Pipe, Within Roadway	LF	49	\$135.00	\$6,615.00				
64	301	46" X 29" Class III Elliptical R.C. Pipe, Within Roadway	LF	113	\$180.00	\$20,340.00				
65	301	60" X 36" Class III Elliptical R.C. Pipe, Within Roadway	LF	126	\$245.00	\$30,870.00				
66	302	4" Drop Inlet (Type MO)	EA	3	\$4,200.00	\$12,600.00				
67	302	6" Drop Inlet (Type MO)	EA	1	\$6,000.00	\$6,000.00				
68	302	3' X 5' Drop Inlet (Type ST w/ Type C Neenah Grates)	EA	1	\$4,800.00	\$4,800.00				
69	302	3' X 6' Drop Inlet (Type ST w/ Type C Neenah Grates)	EA	1	\$5,400.00	\$5,400.00				
70	302	5' X 7' Drop Inlet (Type Special)	EA	1	\$7,200.00	\$7,200.00				
71	302	6' X 7.5' Drop Inlet (Type Special)	EA	1	\$8,400.00	\$8,400.00				
72	302	5' X 7.5' Drop Inlet (Type Special Reverse Throat)	EA	1	\$6,600.00	\$6,600.00				
73	302	6' X 6' Drop Inlet (Type Special Reverse Throat)	EA	1	\$7,200.00	\$7,200.00				
74	302	6" Junction Box (Circular)	EA	1	\$6,000.00	\$6,000.00				
75	302	7' X 4' Junction Box (Type ST)	EA	2	\$6,000.00	\$12,000.00				
76	302	7' X 7' Junction Box (Type ST)	EA	1	\$7,800.00	\$7,800.00				
77	302	6" Drop Inlet Extension	EA	8	\$2,500.00	\$20,000.00				
78	401	5" Aggregate Base Course	SY	2,864	\$10.00	\$28,640.00				
79	401	10" Aggregate Base Course	SY	134	\$16.00	\$2,144.00				
80	403	Asphalt Concrete Hot Mix Surface Course	Ton	355	\$120.00	\$42,600.00				
81	403	Asphalt Concrete Hot Mix Binder Course	Ton	500	\$100.00	\$50,000.00				
82	405	Asphalt Concrete Patching for Maintenance of Traffic	Ton	25	\$200.00	\$5,000.00				





CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 2  
EMMA AVENUE AND PARK STREET INTERSECTION  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
83	501	Concrete Curb and Gutter (Type - A)	LF	1,752	\$30.00	\$55,040.00	\$18.50	\$32,412.00	\$22.85	\$39,682.80
84	502	4" Thick Concrete Sidewalk	SY	160	\$57.00	\$9,120.00	\$58.00	\$9,280.00	\$55.16	\$8,825.60
85	503	Concrete Driveway	SY	270	\$75.00	\$20,250.00	\$64.00	\$17,280.00	\$59.47	\$16,056.90
86	503	Asphalt / Concrete Driveway Removal	SY	393	\$17.00	\$6,681.00	\$13.00	\$5,109.00	\$12.54	\$4,928.22
87	505	Seeding	AC	1	\$3,500.00	\$3,500.00	\$4,000.00	\$4,000.00	\$4,012.08	\$4,012.08
88	505	Sodding	SY	714	\$4.50	\$3,213.00	\$4.50	\$3,213.00	\$3.89	\$2,848.86
89	505	Additional Watering	MG	100	\$45.00	\$4,500.00	\$50.00	\$5,000.00	\$54.19	\$5,419.00
90	507	12" Striping (Thermoplastic)	LF	344	\$15.00	\$5,160.00	\$6.00	\$2,064.00	\$18.26	\$5,683.44
91	507	6" Striping (Thermoplastic)	LF	2,107	\$2.50	\$5,267.50	\$4.25	\$8,954.75	\$3.25	\$6,847.75
92	507	Pavement Symbols (Thermoplastic)	EA	14	\$350.00	\$4,900.00	\$350.00	\$4,900.00	\$433.50	\$6,069.00
93	509	Erosion Control	LS	1	\$20,000.00	\$20,000.00	\$7,200.00	\$7,200.00	\$10,000.00	\$10,000.00
94	510	Traffic Control	LS	1	\$10,000.00	\$10,000.00	\$19,000.00	\$19,000.00	\$50,000.00	\$50,000.00
95	511	Mobilization (not to exceed 5% of contract price)	LS	1	\$50,000.00	\$50,000.00	\$53,000.00	\$53,000.00	\$64,000.00	\$64,000.00
96	513	Cast-in-Place Tactile Panel	SF	395	\$35.00	\$13,825.00	\$15.00	\$5,925.00	\$19.93	\$7,872.35
97	513	Handicap Ramp Concrete	SY	41	\$75.00	\$3,075.00	\$70.00	\$2,870.00	\$62.48	\$2,561.68
98	516	Cold Milling Asphalt Pavement	SY	747	\$6.00	\$4,482.00	\$20.00	\$14,940.00	\$15.00	\$11,205.00
99	707	2" Non-Metallic Conduit (Irrigation Sleeves)	LF	141	\$15.00	\$2,115.00	\$10.00	\$1,410.00	\$9.21	\$1,298.61
100	707	4" Non-Metallic Conduit (SWEPCO)	LF	950	\$20.00	\$19,000.00	\$15.00	\$14,250.00	\$45.52	\$43,244.00
101	707	4" Non-Metallic Conduit (SWEPCO)	LF	400	\$30.00	\$12,000.00	\$19.00	\$7,600.00	\$59.61	\$23,844.00
102	707	6" Non-Metallic Conduit (SWEPCO)	LF	1,550	\$35.00	\$54,250.00	\$39.00	\$60,450.00	\$92.12	\$142,786.00
103	SP-3	Street Lighting (Emma/Park/Berry)	LS	1	\$128,000.00	\$128,000.00	\$149,000.00	\$149,000.00	\$300,000.00	\$300,000.00
104	SP-7	Furnish and Install Sign with Decorative Support	EA	8	\$1,800.00	\$14,400.00	\$750.00	\$6,000.00	\$1,083.78	\$8,670.08
105	SP-12	8" U.T. Stamped Colored Concrete (Sidewalk/Ramps)	SY	682	\$100.00	\$68,200.00	\$139.50	\$95,139.00	\$210.93	\$143,854.26
106	SP-12	8" U.T. Stamped Colored Concrete (Islands)	SY	180	\$110.00	\$17,800.00	\$174.00	\$27,540.00	\$188.89	\$30,190.40
107	SP-15	Irrigation Adjustments	LS	1	\$10,000.00	\$10,000.00	\$10,000.00	\$10,000.00	\$10,000.00	\$10,000.00
108	SP-17	12" Planting Soil Mixture, Installed	SY	190	\$15.00	\$2,850.00	\$23.00	\$4,370.00	\$19.88	\$3,777.20
109	SP-17	3" Shredded Hardwood Mulch, Installed	SY	180	\$30.00	\$5,700.00	\$9.50	\$1,805.00	\$8.29	\$1,575.10
110	SP-18	6" Schedule 40 PVC Pipe, Installed (Roof Drain)	LF	254	\$42.00	\$10,668.00	\$16.00	\$4,064.00	\$46.41	\$11,788.14
111	SP-19	Concrete Curb (Type 2 Special) (1'-0")	LF	169	\$25.00	\$4,225.00	\$27.00	\$4,583.00	\$49.35	\$8,340.15
112	SP-20	Remove, Salvage, and Reinstall Business Sign	EA	1	\$2,000.00	\$2,000.00	\$7,000.00	\$7,000.00	\$2,709.40	\$2,709.40
TOTALS						\$1,057,043.50		\$1,243,974.45		\$1,489,381.72





CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 3  
PARK STREET AND CAUDLE AVENUE WATER AND SEWER RELOCATIONS  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
113	SP-02	Utility Mobilization (Not to exceed 5%)	L.S.	1	\$12,000.00	\$12,000.00	\$16,000.00	\$16,000.00	\$6,670.08	\$6,670.08
114	SP-02	Utility Trench Excavation Safety Systems	L.S.	1	\$5,000.00	\$5,000.00	\$18,000.00	\$18,000.00	\$1,083.76	\$1,083.76
115	SP-02	Spot Dig and Verify Existing Utility Locations	L.S.	1	\$5,000.00	\$5,000.00	\$18,000.00	\$18,000.00	\$3,783.18	\$3,783.18
116	SP-02	8" DI Water Line	L.F.	800	\$80.00	\$72,000.00	\$185.00	\$148,500.00	\$86.71	\$89,739.00
117	SP-02	8" Gate Valve	EA	10	\$3,000.00	\$30,000.00	\$2,400.00	\$24,000.00	\$2,167.52	\$21,675.20
118	SP-02	Ductile Iron Fittings for Water Line	LB.	1,500	\$15.00	\$22,500.00	\$10.50	\$15,750.00	\$10.84	\$16,260.00
119	SP-02	6"x6" Tapping Sleeve and Valve	EA	4	\$5,400.00	\$21,600.00	\$5,950.00	\$23,800.00	\$8,502.56	\$34,010.24
120	SP-02	6" Water Line Cut and Cap	EA	2	\$1,500.00	\$3,000.00	\$3,800.00	\$7,200.00	\$1,950.77	\$3,901.54
121	SP-02	Fire Hydrant Assembly	EA	4	\$6,700.00	\$26,800.00	\$7,250.00	\$29,000.00	\$8,069.06	\$32,276.24
122	SP-02	Salvage Fire Hydrant	EA	1	\$1,000.00	\$1,000.00	\$1,800.00	\$1,800.00	\$867.01	\$867.01
123	SP-02	Relocate Water Service and Meter Set	EA	7	\$1,500.00	\$10,500.00	\$2,500.00	\$17,500.00	\$1,642.39	\$12,896.73
124	SP-02	Flowable Fill for Abandoned 6" Pipe	L.F.	810	\$25.00	\$20,250.00	\$23.00	\$18,630.00	\$8.50	\$5,265.00
125	SP-02	Adjust Manhole to Grade	EA	2	\$1,800.00	\$3,600.00	\$700.00	\$1,400.00	\$1,083.76	\$2,167.52
126	SP-02	Trench Undercut and Backfill	C.Y.	100	\$60.00	\$6,000.00	\$70.00	\$7,000.00	\$43.35	\$4,335.00
127	SP-02	Rock Excavation for Utilities	C.Y.	25	\$200.00	\$5,000.00	\$300.00	\$7,500.00	\$108.38	\$2,709.50
128	SP-02	Adjust Water Valve to Grade	EA	5	\$600.00	\$3,000.00	\$300.00	\$1,500.00	\$270.84	\$1,354.70
TOTALS						\$247,250.00		\$353,380.00		\$225,004.68





CITY OF SPRINGDALE  
PARK STREET INTERSECTIONS  
BID TABULATION - SCHEDULE 4  
EMMA AVENUE AND PARK STREET WATER AND SEWER RELOCATIONS  
BID OPENING: March 16, 2021 - 2:00 p.m.

ITEM NO.	SPEC. NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	ENGINEER'S ESTIMATE		Crossland Heavy		APAC Central	
					UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
129	SP-02	Utility Mobilization (Not to exceed 5%)	L.S.	1	\$9,000.00	\$9,000.00	\$11,000.00	\$11,000.00	\$8,670.08	\$8,670.08
130	SP-02	Utility Trench Excavation Safety Systems	L.S.	1	\$5,000.00	\$5,000.00	\$18,000.00	\$18,000.00	\$1,625.64	\$1,625.64
131	SP-02	Spot Dig and Verify Existing Utility Locations	L.S.	1	\$5,000.00	\$5,000.00	\$12,000.00	\$12,000.00	\$3,793.16	\$3,793.16
132	SP-02	12" DI Water Line	L.F.	391	\$90.00	\$35,190.00	\$185.00	\$72,335.00	\$157.15	\$61,445.65
133	SP-02	12" Butterfly Valve	EA.	2	\$3,600.00	\$7,200.00	\$4,500.00	\$9,000.00	\$3,793.16	\$7,586.32
134	SP-02	Ductile Iron Fittings for Water Line	LB.	2,000	\$15.00	\$30,000.00	\$10.50	\$21,000.00	\$10.84	\$21,680.00
135	SP-02	12"x12" Tapping Sleeve and Valve	EA.	2	\$9,000.00	\$18,000.00	\$10,758.60	\$21,517.20	\$11,921.38	\$23,842.72
136	SP-02	6"x6" Tapping Sleeve and Valve	EA.	1	\$5,400.00	\$5,400.00	\$5,900.00	\$5,900.00	\$6,502.56	\$6,502.56
137	SP-02	Swing Connection	EA.	1	\$3,600.00	\$3,600.00	\$4,450.00	\$4,450.00	\$3,251.28	\$3,251.28
138	SP-02	6" Water Line Cut and Cap	EA.	1	\$1,500.00	\$1,500.00	\$3,050.00	\$3,050.00	\$1,950.77	\$1,950.77
139	SP-02	12" Water Line Cut and Cap	EA.	3	\$1,800.00	\$5,400.00	\$3,450.00	\$10,350.00	\$3,034.53	\$9,103.59
140	SP-02	Concrete Anchor Collar Block	EA.	1	\$3,600.00	\$3,600.00	\$4,500.00	\$4,500.00	\$1,625.64	\$1,625.64
141	SP-02	Fire Hydrant Assembly	EA.	1	\$6,700.00	\$6,700.00	\$7,200.00	\$7,200.00	\$6,069.05	\$6,069.05
142	SP-02	Salvage Fire Hydrant	EA.	1	\$1,000.00	\$1,000.00	\$1,600.00	\$1,600.00	\$887.01	\$887.01
143	SP-02	Relocate Water Service and Meter Set	EA.	2	\$1,500.00	\$3,000.00	\$2,500.00	\$5,000.00	\$1,842.39	\$3,684.78
144	SP-02	Flowable Fill for Abandoned 12" Pipe	L.F.	290	\$85.00	\$24,650.00	\$23.00	\$6,670.00	\$10.84	\$3,143.80
145	SP-02	Flowable Fill for Abandoned 6" Pipe	L.F.	30	\$25.00	\$750.00	\$25.00	\$750.00	\$6.50	\$1,950.00
146	SP-02	20" Steel Encasement by Open Cut	L.F.	53	\$250.00	\$13,250.00	\$195.00	\$10,335.00	\$243.85	\$12,924.05
147	SP-02	Concrete Cap	C.Y.	60	\$90.00	\$4,950.00	\$71.00	\$3,905.00	\$37.93	\$2,096.15
148	SP-02	Trench Undercut and Backfill	C.Y.	60	\$60.00	\$3,600.00	\$70.00	\$3,500.00	\$43.35	\$2,167.50
149	SP-02	Rock Excavation for Utilities	C.Y.	15	\$200.00	\$3,000.00	\$300.00	\$4,500.00	\$108.38	\$1,625.70
TOTALS						\$188,590.00		\$236,562.20		\$183,840.25





**Webb, D. Jeffrey**

---

**From:** Dan Thompson <dthompson@heavycontractors.com>  
**Sent:** Wednesday, April 7, 2021 4:47 PM  
**To:** Webb, D. Jeffrey  
**Subject:** Park Street Intersection - Springdale  
  
**Categories:** Filed by Newforma

Good afternoon Jeff,

Sorry it took me this long to get this potential cost savings priced and sent over to you.

We have proposed 3 VE options for consideration:

1. Eliminate Light Pole fixtures & wire ( Bid Items 31 & 103)  
Net Deduct \$151,620
  - a. We would still install the light pole foundations and run all conduit.
  - b. We would not purchase or install any light poles or pull any wire.
2. Switch Stamped concrete at Claudle to plain concrete on both 6" & 8" thicknesses (Bid Items 42 & 45)  
Net Deduct \$81,196
  - a. 6" concrete would be at unit price of \$64/SY matching unit price on Bid Item 32 quantity of 898 SY
  - b. 8" concrete priced at \$88/SY quantity of 161 SY
3. Closing Emma/Park Intersection for utility installs and total intersection reconstruct. 3-4 month duration  
Net Deduct \$92,769
  - a. MOT of traffic gets easier
  - b. Asphalt sub has fewer mobilizations
  - c. Increased efficiencies during construction.
  - d. NOTE: Water & Sewer work will be imperative to meet this schedule, and most likely we will Encounter some unknowns. We will need answers ASAP to be able to meet this construction window.

I realize that closing Emma is or could be seen very negatively by the city and rightfully so. But there is some definite cost savings there for us. I would propose to do this work over the summer starting as soon as school was out or shortly thereafter. I also realize that the city has the Rodeo of the Ozarks parade and involves this intersection being opened. That said, we could make temporary plans for this event and coordinate our work to have little to no effect on the parade. Any temporary improvements costs, depending on what all that involves would be priced and come off the net deduct for closing this intersection.

**Total potential deduct is \$325,585 for a grand total of \$2,712,661.**

Please let me know if you have any questions, and I look forward to hearing back from you or the city.

Thanks,





**Dan Thompson**  
*Arkansas Division Manager*  
705 S. Lincoln  
Lowell, AR 72745

t: 479-347-7960  
c: 479-366-1637  
dthompson@heavycontractors.com  
www.heavycontractors.com







# **City of Springdale Low-Impact Development Design Guide**



# **City of Springdale**

## **Low Impact Development Design Guide**





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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BMP	Best Management Practice
EPA	United States Environmental Protection Agency
EPDM	ethylene propylene diene monomer
F	Fahrenheit
ft.	Feet
in	Inches
LID	Low Impact Development
MCBUR	Monolithic multi-ply hot asphalt mineral surfaced built-up-roof
PVC	Polyvinylchloride
SCS	Soil Conservation Service
TPO	thermoplastic olefin
TSS	Total Suspended Solids
US	United States
WMS	Watershed Management Services



## VARIABLES AND CONSTANTS

A.....	Contributing Area (feet <sup>2</sup> )
A <sub>a</sub> .....	Contributing Area (acres)
A <sub>f</sub> .....	Bioretention cell Footprint (feet <sup>2</sup> )
A <sub>i</sub> .....	Trench Footprint (feet <sup>2</sup> )
A <sub>o</sub> .....	Orifice Opening Area (feet <sup>2</sup> )
C.....	Runoff Coefficient per Chapter 106
C <sub>d</sub> .....	Coefficient of Discharge
D <sub>i</sub> .....	Infiltration Trench Depth (feet)
D <sub>rs</sub> .....	Total Depth of Bioretention cell With Subdrain (feet)
E <sub>d</sub> .....	Depth of the Engineered Soils (feet)
F <sub>d</sub> .....	Freeboard (inches)
G.....	Grate Reduction Factor
g.....	Gravitational Constant (feet/second <sup>2</sup> )
H.....	Head (feet)
h <sub>b</sub> .....	Height of the Berm (feet)
I.....	Design Infiltration Rate (inches/hour)
I <sub>e</sub> .....	Infiltration Rate of Engineered Soils (inches/hour)
L <sub>f</sub> .....	Width of Filter Strip Parallel to Flow Path (feet)
L <sub>i</sub> .....	Length of Infiltration Trench (feet)
L <sub>r</sub> .....	Approximate Length of Bioretention cell Along the Axis of the Subdrain (feet)
N.....	Manning's "n" Roughness Coefficient
N <sub>o</sub> .....	Number of Orifices
N <sub>s</sub> .....	Number of Outfall Structures
n <sub>s</sub> .....	Storage Media Void Ratio
P.....	Target Precipitation (inches)
P <sub>d</sub> .....	Depth of Ponded Water (inches)
P <sub>s</sub> .....	Perimeter of the Stand Pipe (feet)
Q.....	Flow Rate (feet <sup>3</sup> /second)
q.....	Volumetric Discharge per Foot Width (feet <sup>3</sup> /second-foot)
S.....	Slope of Filter Strip (ft/ft)
S <sub>d</sub> .....	Depth Required for Subdrain Diameter and Drain Rock (feet)
t.....	Detention Time (hours)
TIV.....	Target Infiltration Volume (feet <sup>3</sup> )
T <sub>t</sub> .....	Travel Time through Filter Strip (minutes)
V <sub>w</sub> .....	Volume of a Wedge (feet <sup>3</sup> )
V.....	Velocity (feet/second)
W <sub>f</sub> .....	Width of Filter Strip Parallel to Flow (feet)
W <sub>fp</sub> .....	Width of Filter Strip Perpendicular to Flow Path (feet)
W <sub>i</sub> .....	Width of Infiltration Trench (feet)
W <sub>if1</sub> .....	Width of Infiltration Trench and One Filter Strip (feet)
W <sub>if2</sub> .....	Width of Infiltration Trench and Two Filter Strips (feet)
W <sub>r</sub> .....	Width of Bioretention cell (feet)
Y.....	Allowable Depth of Flow (inches)







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## 1 Introduction

The *Low Impact Development Design Guide* has been developed by the City of Springdale to provide the engineering and development community with additional guidance for the design of infiltration controls as stormwater mitigation. This manual also introduces other infiltration controls for consideration such as pervious pavements. The application of such mechanisms and strategies is referred to as Low Impact Development (LID).

LID is a storm water management strategy that focuses on maintaining or restoring the natural hydraulic functions of a site for the purpose of water resources protection. LID uses a decentralized approach that disperses flows and manages runoff closer to where it originates, as opposed to collecting storm water in a piped or channelized network and managing it at a large-scale “end of pipe” location. This management practice focuses on mimicking the natural retention, filtration, and infiltration mechanisms that storm water runoff would encounter on an undeveloped site. Therefore, the most important factor to consider in the application of LID to site design is the preservation of native vegetation and natural drainage features.

An essential part of the LID approach is conserving portions of the site in its predeveloped state to preserve the hydrologic functions of the site. To achieve this, site planners should identify and preserve areas that most affect hydrology, such as streams, wetlands, floodplains, steep slopes, and high-permeability soils. The development layout should be adjusted to reduce, minimize, and disconnect the total impervious area. Finally, on-site options for handling runoff from the impervious areas should be employed before conventional off-site storm water practices are used.

In addition to the importance of preserving native vegetation and natural drainage features, gains are made in the effort to mimic natural conditions by reducing and or disconnecting proposed impervious surfaces. Areas of pavement that can be easily broken up into multiple disconnected impervious surfaces include traffic lanes, parking lots, and paved walkways. Traffic lanes can be separated by pervious medians that receive runoff from roadway surfaces. Parking lots can be designed to incorporate vegetated strips of land to collect and convey runoff. Paved walkways can be separated from roadways by vegetated strips of land providing not only opportunities for infiltration but also increase pedestrian safety.

While water quality treatment is not the principle purpose of LID, these practices also provide water quality benefits. Overall reduction in surface runoff reduces the volume of runoff that can potentially transport pollutants. Infiltration as an LID technique reduces the mass of pollutants by filtration of particles and adsorption of chemicals to soil.



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This LID policy provides guidance for the design of the following LID elements: filter strips (a type of infiltration surface), bioretention cells (a type of infiltration basin), infiltration trenches and pervious pavements. This manual also includes discussions of other LID elements that are applicable for storm water treatment in Northwest Arkansas.

The design guidance presented in this manual is based in part on the requirements presented in Springdale's Drainage Criteria Manual (Chapter 106). When performing the design of an LID element, guidance presented in both manuals should be followed. This guidance is provided to facilitate and encourage the usage of LID elements in development and redevelopment projects within the City of Springdale. **The guidance provided in this manual is not intended to supplant professional judgment.**

### ***1.1 Costs and Benefits of LID***

In 2007, the Environmental Protection Agency (EPA) published a report titled *Reducing Storm Water Costs through Low Impact Development: Strategies and Practices* (EPA, 2007). The report compares the projected or known costs of LID practices with those of conventional storm water management approaches. The EPA defines "traditional approaches" to storm water management as those that typically involve hard infrastructure such as curbs, gutters, and piping.

The report indicates that LID techniques can significantly reduce infrastructure costs by eliminating the need for extensive storm water infrastructure such as underground conveyance systems. The report also notes that by infiltrating or evaporating runoff, LID techniques can reduce the size and cost of flood control structures. In some circumstances, LID practices can offset the costs associated with regulatory requirements for storm water control. However, it should be noted that LID techniques may in some cases result in higher costs due to expensive plant materials, additional site preparation, soil amendments, construction of underdrains, and increased project management costs. Other cost considerations include the amount of land required to implement LID practices and potential additional maintenance requirements.

The above-mentioned cost consideration notwithstanding, case studies reviewed in the EPA report demonstrate that LID practices can reduce project costs and improve the overall environmental performance of a development. Though not all the benefits of the LID applications were monetized, with a few exceptions, LID practices were shown to be both fiscally and environmentally beneficial to communities. In a few case studies, initial project costs were higher than those for conventional designs. In most cases, however, significant savings were realized due to reduced costs for site grading and preparation, storm water infrastructure, and site paving. Total capital cost savings ranged from 15 to 80% when LID techniques were used.

The project benefits that were not monetized in the EPA study include improved aesthetics, expanded recreational opportunities, increased property values due to the desirability of the lots and their proximity to open space, increased marketing potential,



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and faster sales. These are all positive impacts that LID can bring to the surrounding community. On a municipal level, the EPA case studies indicate benefits such as reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows. These benefits save taxpayer dollars and reduce pollution in downstream waters that support wildlife and recreation. This manual is intended to give the design community some of the design tools necessary to implement LID on residential, commercial, and transportation related projects so that both the monetary and non-monetary benefits discussed here can be realized.

In addition to the benefits discussed above, LID elements such as bioretention cells and filter strips can be used to meet drainage requirements in Chapter 106.

### ***1.1 How to Use this Manual***

It is not necessary for designers to read every section of this manual to design a particular LID element. After reading Section 1, designers may turn to the section that addresses the particular LID element of interest. However, being familiar with the design considerations associated with each LID element will greatly assist designers in the proper selection of the element best suited for a particular application.

#### **1.1.1 General Structure of the Design Guidance Sections**

This manual contains three major LID design guidance sections.

- Section 2: Bioretention– Shallow depressions planted with vegetation, underlain by local or engineered soils and a subdrain and/or impermeable liner.
- Section 3: Infiltration Trenches – Rectangular excavations lined with geotextile filter fabric and filled with coarse stone aggregate that serve as underground infiltration reservoirs for sheet flow runoff from impervious surfaces such as parking areas.
- Section 4: Permeable Pavements – Permeable interlocking concrete pavers underlain by local or engineered soils and a subdrain and/or permeable liner. Spaces between pavers are filled with washed, small-sized joint aggregate.

The development of a proper LID element design can be accomplished by following the guidance provided in Sections 2, 3, and 4 of this manual. Section 5 is provided to introduce additional LID elements for consideration. While the guidance provided in Section 5 is not as in-depth as that provided in the other sections, the information should be adequate to assist designers in the appropriate application and design for these elements.

A brief description of the LID element is provided at the beginning of each section. The design process is then presented in three major sections: preliminary site evaluation, preliminary design, and final design. In the preliminary site evaluation subsection, the minimum considerations to be evaluated to establish that a site is, or is not, a good



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candidate for the use of the particular LID element are presented. These considerations are in addition to the basic site evaluation considerations presented in Subsection 1.3. At the end of each preliminary site evaluation subsection, a checklist is introduced to assist designers in conducting a preliminary site evaluation. In the preliminary design subsection, the minimum considerations to be evaluated during the preliminary design of each LID element are presented. Where necessary, these discussions include equations to be used during the preliminary design. At the end of each preliminary design subsection, a calculation table is introduced to assist designers in conducting a preliminary design. In the final design subsection, the minimum considerations to be addressed during the final design are discussed.

Design examples for each of the three LID elements are provided in the appendices of this manual. Each design example starts with a brief description of the theoretical site being considered for the application of the particular LID element. The description is followed by a checklist for an example preliminary site evaluation. The preliminary design example is then presented using a preliminary design calculation table. In the final design example sections, discussions are provided of how the minimum considerations presented in each section are to be addressed in the final design. Conceptual design figures are also presented.

#### **1.1.2 Selecting an LID Element**

Bioretention and infiltration trenches are suitable for applications where infiltration of the adjusted 2-year, 24-hour storm event is desired. Thus, by incorporating these LID elements into small and large developments, designers can potentially limit the amount of infrastructure required to meet the requirements listed in Chapter 106.

Filter strips are suitable for applications where treatment of the first flush of runoff is desired. Filter strips are also suitable for use as pretreatment devices upstream of other LID elements such as bioretention cells and infiltration trenches.

Each of the elements presented in Sections 2 through 4 of this manual are suitable to a wide range of applications. Table 1 below provides some suggestions for suitable applications for each element. To perform a detailed evaluation of whether or not a particular LID element is suitable for application to a particular site or portion of a site, performance of a preliminary site evaluation and a preliminary site design is required.



**Table 1 – Suggested Suitable Applications for LID Elements**

LID Element	Parking Lot Runoff	Roof Top Runoff	Roadway Runoff	Airport Drainage	Residential Development	Pretreatment
Bioretention	Yes	Yes	Yes	No	Yes	No
Infiltration Trenches	Yes	Yes	Yes	Yes	Yes	No
Filter Strips	Yes	No	Yes	Yes	Yes	Yes
Permeable Pavers	Yes	Yes	Yes	No	Yes	No

**1.2 Basic Site Evaluation Considerations**

The considerations listed below should be included in the site evaluation for each of the LID elements in Section 2 through Section 4. Considerations specific to the particular elements are listed under the preliminary site evaluation discussion within each section.

**1.2.1 Infiltration Rate of the Surrounding Soil**

The utility of LID elements such as bioretention cells, infiltration trenches, and soak-away pits is dependent on the rate at which the local soil can infiltrate storm water. To operate properly, these LID elements should completely infiltrate storm water runoff from a particular event within 48 hours. Thus, soils with low infiltration rates are not desirable.

Infiltration rates must be estimated based on site investigations. All LID designs must be accompanied by a geotechnical report addressing sections 1.2.1- 1.2.4. Infiltration testing includes soil borings or test pits in the vicinity of the proposed facility as well as physical in-situ infiltration tests. Accepted engineering methods should be used. The acceptable range of measured infiltration rates of soils in an area being considered for use of these LID elements is 0.3 to 8 inches/hour. These infiltration rates must be representative of the soil at the bottom of the proposed facility. The minimum infiltration rate does not apply to bioretention cells with impermeable liners (known as “lined bioretention cells”).

For design purposes, the measured infiltration rate of soils is adjusted using a factor of safety to account for soil non-homogeneity and to reflect reduction in infiltration capacity over the life of the facility. Equations in this manual use design rather than measured infiltration rates and 1 inch per hour is specified as the maximum design infiltration rate.

Use of higher design infiltration rates may be allowed, based on site specific investigation.

**1.2.2 Depth to Groundwater**

To protect groundwater resources, it is important to provide ample separation between LID elements and the surface of the local groundwater table. The minimum separation distance between the seasonal high groundwater table elevation and the bottom of infiltration trenches is 4 feet. The minimum separation distance between the seasonal



high groundwater table elevation and the surface of an unlined bioretention cell is 4 feet. Due to difficulties with bioretention cell construction at or near the groundwater surface, the minimum separation distance between the bottom of lined bioretention cells and the seasonal high groundwater table elevation is 2 feet.

### **1.2.3 Depth to Bedrock or Relatively Impervious Soils**

Bedrock or Hydrologic Soil Group Class D soils directly below the bottom of LID elements can have undesirable effects, such as limiting the infiltrative capacity of the element, or in the case of highly fractured bedrock, allowing untreated discharge to reach groundwater. To reduce the possibility of limited infiltration or treatment due to the presence of bedrock or impervious soils, the minimum separation distance between these materials and the bottom of unlined bioretention cells and infiltration trenches is 3 feet.

### **1.2.4 Separation Distance from Foundations and Road Subgrades**

Unlined bioretention cells and infiltration trenches must be either outside of the zone of influence of foundations and road subgrades or separated from these structures by a horizontal distance of 20 feet. The zone of influence refers to the area of the surrounding subgrade that is critical to proper function and support of the overlying and/or adjacent foundation or road subgrade. The zone of influence can be defined as the area bounded within a 3-dimensional surface extending at a 1:1 slope down and away from the outer edge of a foundation or road subgrade. An additional horizontal setback may be required when there is potential for surface seepage due to the vertical elevation difference between the bottom of the infiltration facility and adjacent land or property due to steep slopes or retaining walls.

## ***1.3 Construction Considerations***

Construction of the LID elements discussed in Sections 2 through 4 of this manual shall incorporate the considerations discussed below in addition to those provided in the construction considerations discussion presented in the section specific to each LID element.

### **1.3.1 Excavation**

Care must be taken during the excavation of areas for LID elements to assure that the existing infiltrative capacity of the soil is not reduced due to compaction. Excavation should be performed by machinery operating adjacent to the excavated area, if possible. When it is necessary for excavation equipment to operate within the footprint of an LID element, lightweight, low ground contact pressure equipment should be used. Heavy equipment with narrow tracks, narrow tires or large lugged, high pressure tires should not be allowed on the bottom of the excavations. Following excavation, the base of the excavation should be ripped to refracture the soil to a minimum of 12 inches.



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### 1.3.2 Excess Sediment

Care must be taken to assure that LID elements are not overburdened with sediment generated by construction in adjacent areas. LID elements should not be used as sediment control facilities for construction. Runoff from adjacent construction should be directed away from LID elements with temporary diversion swales or other protection. Flow to newly constructed LID elements should not be allowed until all of the contributing area is stabilized according to the satisfaction of the engineer.

### 1.4 Separation from Underground Utilities

Generally, LID elements should have the following separation distances from underground utilities:

Wastewater – 10 feet  
Electric – 6 feet

Drinking Water – 10 feet  
Gas – 6 feet

Deviation from these separation distances may be granted at the discretion of the Springdale Engineering Department and in cooperation with the utility company or companies.

### 1.5 Equations

This document contains a number of design equations that are provided to assist the development community in the proper design of the LID elements presented in this manual. A brief discussion of each equation, including an explanation of constants, is provided in Appendix A.

### 1.6 LID Design Notes

The following design notes are common to the design of bioretention, infiltration trenches, and filter strips.

- Rainfall Depth: The guidance provided in this manual has been developed in part to assist the development community in the design of LID elements capable of infiltrating the base 2-year, 24-hour event.
- Runoff Coefficient per Chapter 106: The preliminary design process for bioretention, infiltration trenches, and filter strips requires the calculation and input of the Runoff Coefficient. The term “Runoff Coefficient” is used in this document to refer to the “Rational Method Coefficient” as described in Chapter 106. In all cases, the Runoff Coefficient is to be calculated according to guidance contained in Chapter 106.
- Soil Infiltration Rates: The design of bioretention cells, infiltration trenches, and filter strips requires knowledge of the local infiltration rate. In addition, when



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engineered soil is used in a bioretention cell design, the design process requires knowledge of the infiltration rate of the engineered soil. Measured infiltration rates should be adjusted to design infiltration rates using appropriate factors of safety. For estimation of the infiltration rate for engineered soils, designers are referred to Appendix C of this manual.

- **Overflow Structures:** In all cases, overflow structures for LID elements should be designed and sized to assure that during a 100-year 24-hour storm water is provided a clear, safe, non-destructive path to an appropriately sized conveyance system without causing any kind of localized flooding.
- **Target Infiltration Volume (TIV):** The term Target Infiltration Volume is used in this manual to define the target volume for design of LID elements.



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## 2 Bioretention

A bioretention cell or bioswale is a shallow depression planted with vegetation, underlain by local or engineered soils and a subdrain and/or impermeable liner. Both bioretention cells and bioswales are intended to temporarily retain and treat storm water runoff through filtration and other mechanisms. A subdrainage system that discharges to an open channel or storm drain is required.

Bioretention cells are an extremely versatile LID element and several variations exist. In Springdale, all Bioretention cells require a subdrain. Impervious liners are sometimes required to protect groundwater or to protect adjacent foundations. Conceptual profile drawings of both types of bioretention cells are presented in Figure 1.

The soil within a bioretention cell serves as the filtration medium and also provides a rooting area for the bioretention cell plants. The bioretention cell plants play an important role in the storm water treatment process, as they encourage infiltration (if the bioretention cell is not lined) and provide treatment for pollutants, such as total petroleum hydrocarbons, through the process of phytoremediation. In addition to their value as storm water treatment devices, bioretention cells can be designed as attractive landscaping features.

Bioretention cells are a good choice to treat and/or infiltrate runoff from impervious parking lots, both high- and low-density housing developments and recreation areas. They can also be used in high-density urban applications when the proper precautions are taken to protect adjacent foundations. Bioretention cells are capable of removing fine suspended solids as well as other pollutants including copper, lead, zinc, phosphorous, and nitrogen.

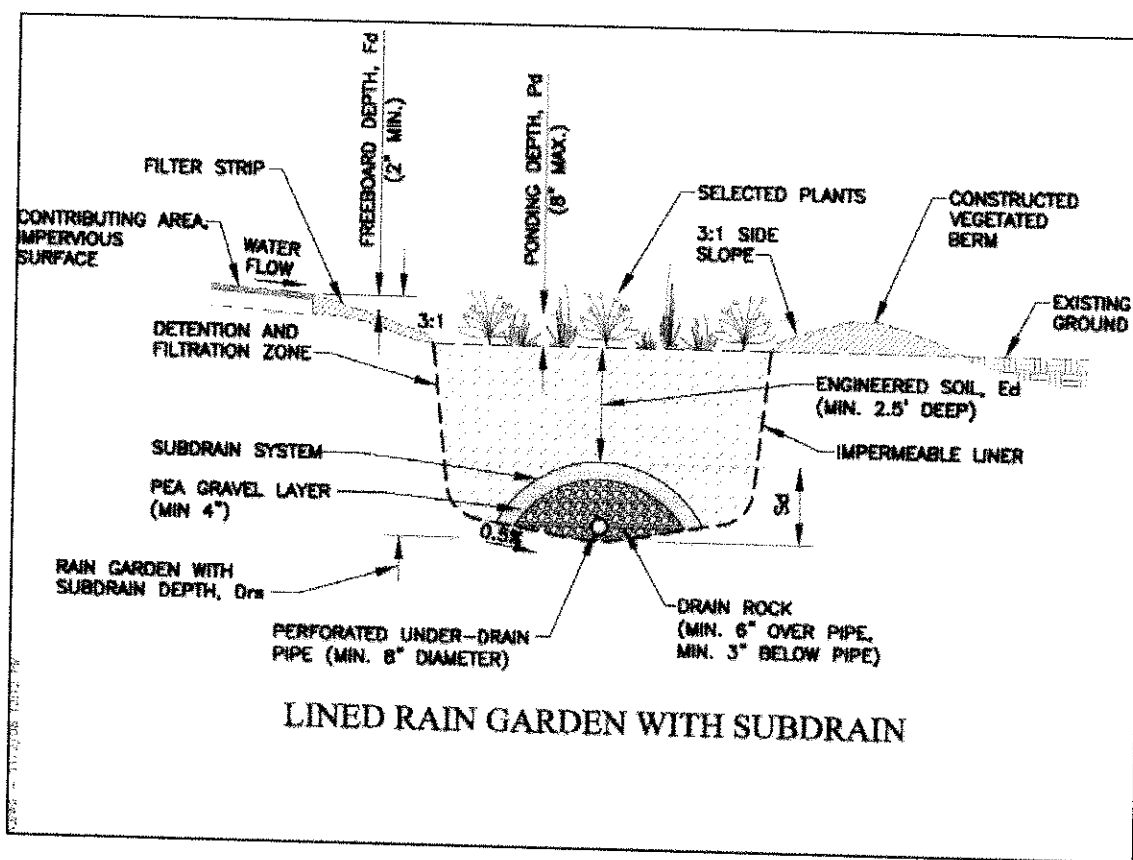
In order for rain gardens and bioswales to be effective, they must be designed to meet the geologic, vertical, and horizontal constraints of a site. The process of developing an appropriate bioretention cell design based on local site constraints is presented in the following sections.

### ***2.1 The Bioretention Cell Design Process***

The bioretention cell design process involves preliminary site evaluation, preliminary and final design, the basic site evaluation considerations discussed in Subsection 1.3, and the following more specific considerations.



Figure 1 – Conceptual Bioretention Cell Profiles





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### **2.1.1 Preliminary Site Evaluation – Bioretention cells**

The following subsections present the minimum site-specific factors, in addition to those discussed in Subsection 1.3, that are to be considered when evaluating a site for the potential use of a bioretention cell to treat storm water runoff. The minimum considerations presented below do not include typical engineering considerations such as utility conflicts and are not a substitute for sound engineering judgment.

#### **2.1.1.a Runoff Source**

Bioretention cells are intended to treat runoff from urban and suburban drainage areas where pollutant loads are related primarily to residential, parking, and road surface runoff. Bioretention cells are not appropriate to receive runoff from industrial facilities or areas where runoff is likely to contain industrial pollutants.

#### **2.1.1.b Contributing Area**

Because of the difficulty of providing retention and infiltration of runoff from a large area within the relatively small footprint of a bioretention cell, it is necessary to limit the size of the area contributing runoff. Generally, a single bioretention cell should not be designed to receive runoff from areas larger than 5 acres. It is possible to treat runoff from very large areas if multiple bioretention cells or bioretention cells in combination with other LID elements are used.

#### **2.1.1.c Slope of Available Area for Bioretention cell**

Bioretention cells are generally difficult to construct on steep sites. This is because the surface of a bioretention cell must be designed to be relatively level to promote infiltration evenly across the surface of the garden. For this reason, the maximum recommended slope of an area where a bioretention cell will be placed is 5%.

#### **2.1.1.d Available Area**

A fundamental consideration to make when evaluating a site for use of a bioretention cell is whether or not there will be adequate space available. A general rule of thumb is that a bioretention cell will require an area that is approximately 10% of the total contributing area. While the exact area required for a bioretention cell can only be established through the design process, this generalization is a good starting point to use during the preliminary site evaluation process.

#### **2.1.1.e Down Gradient Slope**

It's important to consider the slope of adjacent properties that are down gradient of the site to limit the possibility of seepage from the subgrade to the ground surface at lower elevations. For this reason, unlined bioretention cells should not be



used when the average slope of an adjacent down gradient property is 12% or greater. This consideration does not apply to lined bioretention cells.

In order to assist designers in the evaluation of sites for use of a bioretention cell, a checklist of each of the above considerations, as well as those discussed in Subsection 1.3, is provided in Table 2. A site must meet all of the requirements discussed in these subsections to be a candidate for the use of a bioretention cell.

**2.1.2 Preliminary Design Considerations – Bioretention cells**

If the preliminary site evaluation indicates that the site is a good candidate for the use of a bioretention cell to treat storm water, the preliminary design can be carried out to establish the approximate dimensions of the bioretention cell. Knowing the required dimensions of the bioretention cell will allow for further evaluation of whether or not there is adequate space within the site to accommodate one. There are several important considerations to be made when performing a preliminary design. Descriptions of the minimum preliminary design considerations are provided in the subsections below.

**2.1.2.a Target Treatment Volume**

The target treatment volume will ultimately determine the surface area for the bioretention cell. The target treatment volume is referred to in this manual as the Target Infiltration volume. This volume is a function of the contributing area, runoff coefficient, and target precipitation. The equation relating the three variables is presented below.

$$TIV = \frac{A \cdot P \cdot C}{12}$$

Equation 2.1

- TIV = Target Infiltration Volume (feet<sup>3</sup>)
- A = Contributing Area (feet<sup>2</sup>), generally less than 5 acres
- P = Target Precipitation (inches), 1.1 for the 1–Year, 24–Hour Storm
- C = Runoff Coefficient

**2.1.2.b Ponding Depth and Freeboard**

Both the design and function of a bioretention cell rely on the garden’s ability to temporarily store a known depth of water at the surface. The maximum allowable ponding depth for bioretention cells is 8 inches. In addition to this ponding depth, a freeboard of 4 inches is also required.



Table 2 – Bioretention cells – Preliminary Site Evaluation Checklist

Site Location:			Evaluated by:			
Date:						
Considerations	Applies to Lined Bioretention cell?	Applies to Bioretention cells with Subdrains?	Requirement/ Recommendation	Site Conditions /Notes	Pass /Fail	Data Source
Soil Infiltration	Y	N	Measured soil infiltration rate must be between 0.3 and 8 in/hr.			
Proximity to Surface Waters	N	Y	Bioretention cell should be located at least 100 feet from surface waters.			
Depth to Seasonal High Groundwater Level	Y	Y	4 feet or more below the top of an unlined bioretention cell and 2 feet or more below the top of a lined rain garden..			
Depth To Bedrock	N	Y	Bedrock must be 3 foot or more below the bottom of a bioretention cell.			
Proximity to Building Foundations	N	Y	Bioretention cell must be located outside of the zone of influence or at least 20 feet from building foundations.			
Proximity to Road Subgrades	N	Y	Bioretention cell must be located outside of the zone of influence or at least 20 feet from road subgrades.			
Runoff Source	Y	Y	Bioretention cell is not to receive runoff containing industrial pollutants.			
Contributing Area	Y	Y	The contributing area must be less than 5 acres.			
Available Area Slope	Y	Y	The slope must be less than or equal to 5%.			
Available Area	Y	Y	The area available for treatment must be at least 10% of the total contributing area.			
Down Gradient Slope	N	Y	Average slope of adjacent down gradient property must be less than 12%.			



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### 2.1.2.c Bioretention cell Footprint and Geometry

The bioretention cell footprint is the total area of the bioretention cell in plan view. The bioretention cell footprint is a function of the target treatment volume, ponding depth, and side slopes. The recommended side slope for a bioretention cell is 3:1 (horizontal: vertical). The equation for determining the bioretention cell footprint is provided below.

$$A_r = \left( \frac{12 * TIV}{P_d} \right) * (0.26 * I_e^{-0.53}) \quad \text{Equation 2.2}$$

$A_r$  = Bioretention cell Footprint (feet<sup>2</sup>)

TIV = Target Infiltration Volume (feet<sup>3</sup>), Equation 2.1

$P_d$  = Depth of Pondered Water (inches), 8 inches maximum

$I_e$  = Infiltration Rate of Engineered Soils (inches/hour)\*, 1.0 inches/hour

Bioretention cells are an extremely versatile LID element in terms of plan view geometry. They can take nearly any shape to fit within the site plan. While there is a great deal of freedom associated with specifying the shape of a bioretention cell, it is important to consider that runoff discharging to the bioretention cell (typically along the long side of the garden) should be spread evenly across the surface of the garden to promote infiltration across the entire garden surface.

### 2.1.2.d Depth of Engineered Soils

The engineered soils within a bioretention cell provide a medium for infiltration and plant growth. In order for the soil to provide adequate treatment, the minimum depth of engineered soils within a bioretention cell is 2.5 feet.

### 2.1.2.e Overflow Structure

All bioretention cells must incorporate some kind of emergency overflow structure that will safely transmit any storm water to an appropriately sized storm water conveyance system when ponding depths are exceeded. Overflow structures may include perimeter weirs and/or stand pipes. Depending on the nature of the overflow structure, an underground conveyance system may be necessary, which should be determined at the preliminary design stage.

### 2.1.2.f Subdrain

All bioretention systems in Springdale require a subdrain system that discharges to an open channel or storm drain. Subdrain systems are needed because local soil infiltration rates are low.

Subdrains may serve as discharge points from overflow structures to limit the amount of buried infrastructure necessary for the bioretention cell construction.



Minimum slope of subdrains is 5%.

**2.1.2.g Total Depth**

The total depth of a bioretention cell is the depth from the freeboard elevation to the bottom of the excavation.

For bioretention cells with a subdrain or underground overflow structure within the boundary of the bioretention cell, the total depth can be calculated with the following relationship.

$$D_{rs} = \frac{P_d + F_d}{12} + E_d + S_d + (0.0005 * L_r)$$

Equation 2.3

- D<sub>rs</sub> = Total Depth of Bioretention cell with Subdrain (feet)
- P<sub>d</sub> = Depth of Pondered Water (inches), 8 inches maximum
- F<sub>d</sub> = Freeboard (inches), 2 inches minimum
- E<sub>d</sub> = Depth of the Engineered Soils (feet), 2.5 feet maximum
- S<sub>d</sub> = Depth Required for Subdrain Diameter and Drain Rock (feet), can assume 1.75 during the preliminary design
- L<sub>r</sub> = Approximate Length of Bioretention cell, Along the Axis of the Subdrain (feet)

*Note: The equation above is intended to assist designers in the conservative estimation of the depth required for the bioretention cell at its deepest point. The exact depth is determined during final design.*

In order to assist designers in the preliminary design of a bioretention cell, a blank sample calculation sheet has been developed and is presented as Table 3. The sample calculation sheet includes the preliminary design considerations and equation discussed above and is presented in three steps.



Table 3 – Bioretention Cell Preliminary Design

Site Location:		Evaluated by:	
Date:			
Step 1: Calculate the Target Infiltration Volume, TIV			Notes
Contributing Area, A		(ft <sup>2</sup> )	
Target Infiltration Rainfall, P	1.1	(in)	Set Value
Runoff Coefficient, C			Per Ch. 106
TIV = A*P*C/12 =		(ft <sup>3</sup> )	Using Equation 2.1
*Step 2: Calculate the Required Bioretention cell Footprint Area			
TIV (from Step 1)		(ft <sup>3</sup> )	
Depth of Poned Water, P <sub>d</sub>		(in)	Maximum of 8 inches
Design Infiltration Rate, I <sub>e</sub> (or I, see Subsection 2.1.2.c)		(in/hr)	1.0 for engineered soils
A <sub>r</sub> = (TIV*12/P <sub>d</sub> ) (0.26*I <sub>e</sub> <sup>-0.53</sup> ) =		(ft <sup>2</sup> )	Using Equation 2.2
Approximate Width, W <sub>r</sub>	W <sub>r</sub> =A <sub>r</sub> /L <sub>r</sub> =	(ft)	
Approximate Length, L <sub>r</sub>	L <sub>r</sub> =A <sub>r</sub> /W <sub>r</sub> =	(ft)	
Step 3: Approximate Bioretention cell Depth, with Subdrain			
P <sub>d</sub> (From Step 2)		(in)	
Freeboard Depth, F <sub>d</sub>		(in)	Minimum of 4 inches
Depth of Engineered Soils, E <sub>d</sub>		(ft)	Minimum of 2.5 feet
Minimum Subdrain Depth, S <sub>d</sub>		(ft)	Assume 1.75 feet
L <sub>r</sub> (From Step 3)		(ft)	
D <sub>rs</sub> = (P <sub>d</sub> +F <sub>d</sub> )/12+E <sub>d</sub> +S <sub>d</sub> +(0.005*L <sub>r</sub> ) =		(ft)	Using Equation 2.3
Note: *See Appendix C for guidance on selecting a value for I <sub>e</sub>			



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#### Step 1 – Calculate the Target Infiltration Volume

This step is based on Equation 2.1 presented in Subsection 2.1.2.a above, and requires the independent calculation of the runoff coefficient per Chapter 106.

#### Step 2 – Calculate the Bioretention cell Footprint

This step involves the application of Equation 2.2 presented in Subsection 2.1.2.c. In this step, the designer must also approximate the length and width values to represent the geometry of the bioretention cell. The product of these numbers should be approximately equal to the calculated footprint area.

#### Step 3 – Approximate Garden Depth

Step 3 involves the application of Equation 2.3, presented in Subsection 2.1.2.g., to determine the approximate depth of the bioretention cell.

Once the site evaluation and preliminary design have been completed, the final design can be conducted.

### **2.1.3 Final Design – Bioretention cells**

In order to develop a final bioretention cell design based on the results of the preliminary design, there are several basic factors that must be addressed. Addressing these factors requires some basic understanding of engineering and hydraulic principles. At a minimum, each of the factors discussed in the subsections below should be considered during final design.

#### **2.1.3.a Specifying the Engineered Soils**

The engineered soils mixture is a critical component in a bioretention cell design. The recommended soil mixture for bioretention cell applications is a mixture of 60 to 65% loamy sand mixed with 35 to 40% compost. An alternative recommended soil mixture consists of 20% to 30% topsoil (sandy loam), 50% to 60% coarse sand, and 20% to 30% compost (or peat). The soil mix should be uniform and free of stones, stumps, roots or other similar material greater than 2 inches in diameter.

#### **2.1.3.b Specifying Bioretention cell Plants**

Bioretention cell plants will assist in the storm water treatment process and contribute to the aesthetic value of the garden. The rain garden or bioswale should be planted with native, perennial vegetation only. There are a wide variety of plants available for use in a bioretention cell. For large plant orders, coordinate with nurseries early to assure an adequate supply will be available. Generally speaking, the selected plants should be tolerant to a wide variety of moisture and salinity conditions, and should not interfere with utilities in the area. A list of suitable plants recommended by the Arkansas Native Plant Society for the Springdale area is provided in Appendix B. This list is a good starting point for plant materials; see the Additional References for more information.



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### 2.1.3.c Subdrain System Design

*Note: Subdrain systems are required in all Bioretention cells in Springdale.*

The subdrain in a bioretention cell performs the important task of removing treated water from the garden soils and transporting it to the storm drain system or outfall. The subdrain system consists of three main components: a subdrain pipe, drain rock, and an aggregate filter blanket. Each of these components is discussed separately below.

The subdrain pipe should be constructed out of slotted polyvinyl chloride (PVC) pipe. The slots should be approximately 0.05 inches wide and 0.25 inches apart. The slots should be arranged in four rows spaced on 45-degree centers, and cover 50% of the circumference of the pipe. The minimum diameter of the drainpipe should be 8 inches and the minimum slope should be 0.5%. The number of subdrains within a bioretention cell should be adequate to handle the full ponding depth discharge rate of the bioretention cell according to Manning's equation.

The subdrain pipe is placed on a layer of drain rock that is a minimum of 3 feet wide and 3 inches thick. A 6-inch thick layer of drain rock should be placed above the drainpipe. The recommended gradation for the drain rock is provided below:

<u>Sieve Size</u>	<u>Percent Passing</u>
¾ inch	100
¼ inch	30-60
US No. 8	20-50
US No. 50	3-12
US No. 200	0-1

An aggregate filter blanket diaphragm (pea gravel) will reduce the likelihood of clogging when placed in a 4-inch layer above the drain rock. Pea gravel should be washed and be 0.25 to 0.5 inches in diameter.

### 2.1.3.d Bottom Grading

In order for the underdrain system to function properly, the bottom of the bioretention cell must be graded to allow the treated water to flow towards the subdrain. The minimum acceptable bottom slope for providing drainage to the subdrain is 0.5%.



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#### **2.1.3.e Specifying the Bioretention cell Impermeable Liner**

An impermeable liner is not a requirement for all bioretention cells. However, liners are required if minimum separation distances from building foundations, road subgrades, or water sources cannot be achieved.

#### **2.1.3.f Overflow Bypass**

Overflow bypass structures are important for the proper design of bioretention cells. An overflow structure can take many forms. Examples include stand pipes discharging to an underground storm drain network, and broad-crested grassed weirs discharging to grassed ditches. All bioretention cells must include some form of overflow bypass sufficient to transmit runoff from a 100-year, 24-hour duration storm event without overtopping the bioretention cell. Overtopping shall be allowed in cases where discharge due to overtopping is provided a clear, safe, non-destructive path to a conveyance system.

#### **2.1.3.g Pretreatment**

Pretreatment for bioretention cells can significantly reduce the amount of maintenance associated with sediment deposition. Filter strips, as described in Section 4, are suitable for providing pretreatment. Where site conditions allow, pretreatment devices are recommended for bioretention cells receiving runoff from parking areas and other areas known to have high sediment loads.

### ***2.2 Bioretention Cell Construction and Maintenance***

#### **2.2.1 Construction Considerations – Bioretention cells**

In addition to the minimum construction considerations discussed in Subsection 1.5, consideration should be given to the placement of engineered soils. Onsite mixing and/or placement of engineered soils should not be performed when the soil or ground is saturated. The engineered soils should be placed and graded by excavators and/or backhoes operating adjacent to the bioretention cell. If machinery must operate in the bioretention cell for excavation, lightweight, low ground contact pressure equipment should be used. The engineered soils should be placed in 12-inch lifts. Compaction of engineered soils should be allowed to occur through natural settlement over time rather than through mechanical means. To speed settling, each lift can be watered to the saturation point.

The minimum considerations presented in this manual do not include some typical engineering considerations such as resolving utility conflicts, and are not a substitute for sound engineering judgment.



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### **2.2.2 Maintenance Considerations – Bioretention cells**

In order to function properly over long periods of time, bioretention cells must be maintained properly and regularly. The following are general considerations that should be addressed when developing a maintenance agreement as required by this policy.

#### **2.2.2.a Watering**

Because the plants selected for bioretention cell applications are to be suitable for a wide range of soil moisture conditions, watering will generally not be required after the plants are well established. However, during the first 2 to 3 years, watering will be required to nurture the young plants. Watering may also be required during prolonged dry periods after plants are established (PSAT, 2003)

#### **2.2.2.b Plant Material**

Depending on the aesthetic requirements of the bioretention cell, occasional pruning and removal of dead plants may be necessary. Periodic weeding will be necessary for the first 2 to 3 years, until the plants are well established (PSAT, 2003). As the garden matures, it may be necessary to prune, thin, or split plants to avoid an overgrown appearance and maintain plant health.

#### **2.2.2.c Mulch**

If mulch is used in a bioretention cell, it should be replaced annually if heavy metal deposition or heavy sedimentation is likely (e.g., if runoff comes from parking lots and roads). If heavy metal deposition and/or sedimentation is not a major concern, the mulch should be amended at least once every 2 years to maintain a 2 to 3-inch depth. If mulch is used, allow for additional depth to account for the thickness of the mulch layer.

#### **2.2.2.d Soil**

In bioretention cells where heavy metals deposition is likely, it is recommended that the engineered soil be removed and replaced once every 20 years. Replacing soil in bioretention cells will provide a prolonged service life.

#### **2.2.2.e Inspection and Trash Removal**

Bioretention cells should be inspected following large rain events. If ponded water persists for more than 24 hours after a rain event, the first six inches of soil may need to be removed and replaced or amended to restore infiltration. This task must be performed carefully to limit damage to established plants. Because of the aesthetic value of bioretention cells, trash should be regularly removed.

### **2.2.3 Bioretention cell Conceptual Design Example**

A conceptual design example for a bioretention cell is provided in Appendix D of this manual.



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### **3 Infiltration Trenches**

An infiltration trench is a rectangular excavation lined with a geotextile filter fabric and filled with coarse stone aggregate. These trenches serve as underground infiltration reservoirs. Storm water runoff directed to these trenches infiltrates into the surrounding soils from the bottom and sides of the trench. Infiltration trenches require pretreatment of storm water runoff to remove large sediments. Pretreatment for infiltration trenches is typically accomplished with the use of filter strips. Trench depths generally range between 2.5 and 10 feet. They can be covered with grating, stone, gabions, sand, or a grassed area with surface inlets. A conceptual drawing of an infiltration trench is provided in Figure 2.

An infiltration trench is a good choice to treat and infiltrate runoff from impervious parking lots, high- and low-density housing developments, and recreation areas. Infiltration trenches can be difficult to use in high-density urban applications due to the amount of area they require for pretreatment, and the potential hazard they pose to adjacent foundations. Infiltration trenches are intended to remove fine suspended solids and other pollutants such as copper, lead, zinc, phosphorous, nitrogen, and bacteria.

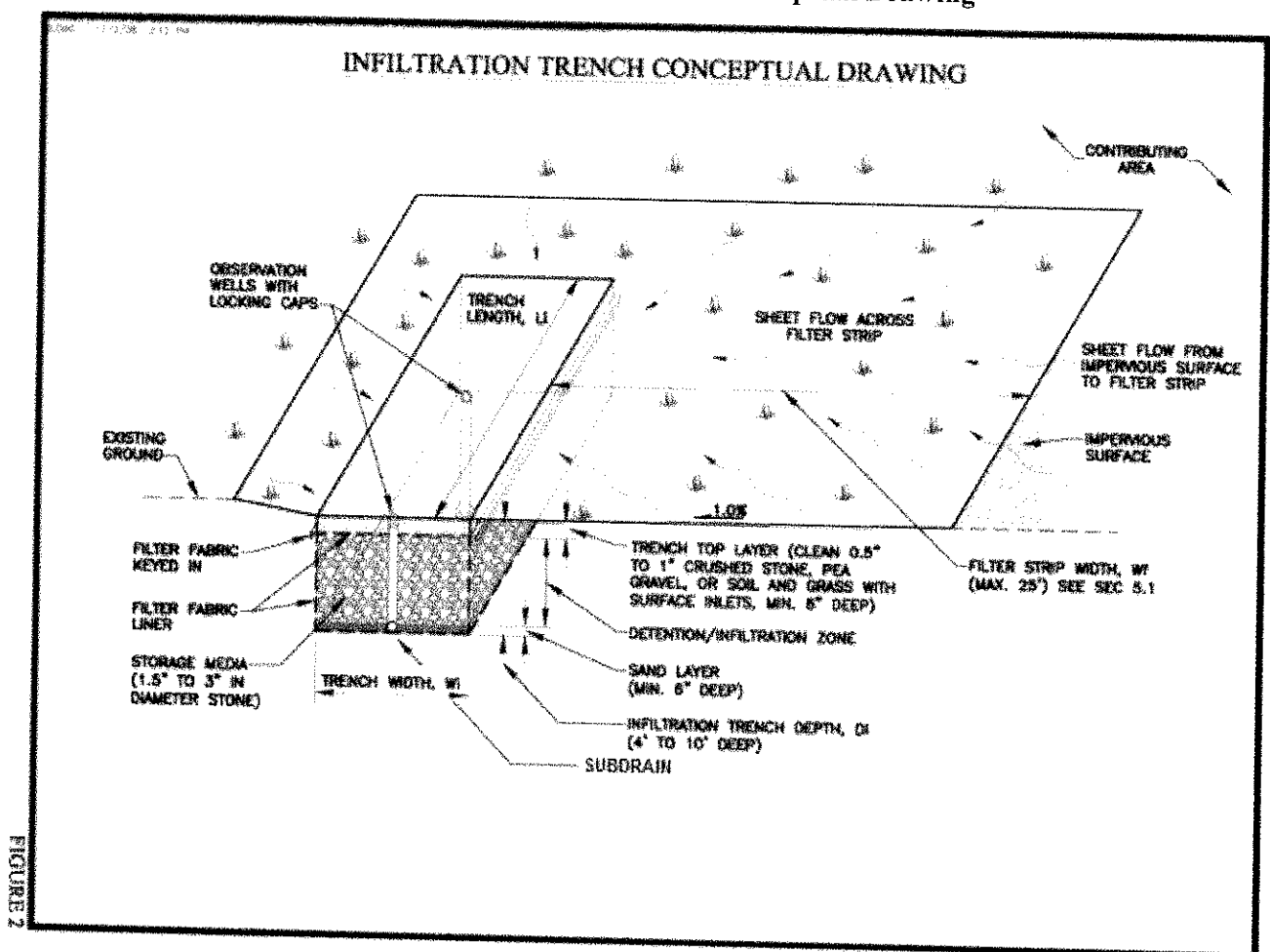
In order for infiltration trenches to be effective, they must be located in areas where the local soil is appropriate for infiltration and they must be designed accordingly. The process for developing an appropriate infiltration trench design based on local site constraints is presented in the following sections. Infiltration trenches must have a subdrain.

#### ***3.1 The Infiltration Trench Design Process***

The infiltration trench design process involves preliminary site evaluation, preliminary and final design, and the basic site evaluation considerations discussed in Subsection 1.3.



Figure 2 – Infiltration Trench Conceptual Drawing





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### **3.1.1 Preliminary Site Evaluation – Infiltration Trench**

The following subsections present the minimum site-specific factors, in addition to those discussed in Subsection 1.3, that are to be considered when evaluating a site for the potential use of an infiltration trench to treat storm water runoff. The minimum considerations presented below do not include some typical engineering considerations such as resolving utility conflicts, and are not a substitute for sound engineering judgment.

#### **3.1.1.a Runoff Source**

Infiltration trenches are intended to treat runoff from urban and suburban drainage areas where pollutant loads are related primarily to parking lot and road surface runoff. Infiltration trenches are not appropriate to receive runoff from industrial facilities where runoff is likely to contain industrial pollutants.

#### **3.1.1.b Contributing Area**

In the past, infiltration trenches have been designed to accommodate large drainage areas. However, long term monitoring suggests that large-scale infiltration is not feasible. The main factor being that infiltration of storm water from a large area into a relatively small area does not reflect the natural hydrologic cycle and generally leads to problems such as groundwater mounding, soil clogging, and soil compaction. It is recommended that the contributing area to an infiltration trench be limited to 3 acres or less.

#### **3.1.1.c Slope of Available Area for Infiltration Trench**

Infiltration trenches are generally difficult to construct on steep sites because the bottom and top surfaces of the trench must be completely level. The design of filter strips to provide pretreatment to runoff is also more problematic on steep sites. For these reasons, the maximum recommended slope of a site being considered for use of an infiltration trench is 5%.

#### **3.1.1.d Available Area**

The area that is required for an infiltration trench can be as much as 15 to 35% of the total contributing area. The most efficient sites are ones in which the contributing area dimensions are nearly square and the infiltration trench can be constructed along one side of the square. Infiltration trenches can be designed to receive runoff from sites with length to width ratios as low as 3:1 with moderate increases in the percentage of the relative area required for the trench. During the site evaluation process, it can be assumed that the area required for the infiltration trench and filter strip(s) is 35% of the total contributing area.



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#### **3.1.1.e Down Gradient Slope**

The slope of adjacent properties that are down gradient of the site is important to consider the possibility of seepage from the subgrade to the ground surface at lower elevations. For this reason, infiltration trenches should not be used when the average slope of an adjacent down gradient property is 12% or greater.

In order to assist designers in the evaluation of sites for use of an infiltration trench, a checklist of each of the above considerations, as well as those discussed in Subsection 1.3, is provided in Table 4. A site must meet all of the requirements discussed in these subsections to be a candidate for the use of an infiltration trench.

#### **3.1.2 Preliminary Design Considerations – Infiltration Trench**

If the preliminary site evaluation indicates that the site is a good candidate for the use of an infiltration trench to treat storm water, the preliminary design can be carried out to establish the approximate dimensions of the trench and pretreatment area. Knowing the required dimensions of the infiltration trench will allow for further evaluation of whether or not there is adequate space within the site to accommodate the trench and pretreatment area. There are several important considerations to be made when performing a preliminary design of an infiltration trench. Descriptions of the recommended preliminary design considerations are provided in the subsections below.



Table 4 – Infiltration Trench – Preliminary Site Evaluation Checklist

Site Location:		Evaluated by:		
Date:				
Considerations	Requirement/Recommendation	Site Conditions/Notes	Pass/Fail	Data Source
Soil Infiltration	Measured soil infiltration rate must be between 0.3 and 8 in/hr.			
Proximity to Surface Waters	Trench should be located at least 100 feet from surface waters.			
Depth to Seasonal High Groundwater Level	Must be 4 feet or more below the bottom of the trench.			
Depth To Bedrock	Bedrock must be 3 feet or more below the bottom of the trench.			
Proximity to Building Foundations	Trench must be located outside of the zone of influence or at least 20 feet from building foundations.			
Proximity to Road Subgrades	Trench must be located at least 20 feet from road subgrades.			
Runoff Source	Infiltration trench is not to receive runoff containing industrial pollutants.			
Contributing Area	The contributing area must be less than 3 acres.			
Available Area Slope	Available area slope must be less than or equal to 5%.			
Available Area	The area available for treatment must be at least 15% of the total catchment area.			
Down Gradient Slope	Average slope of adjacent down gradient property must be less than 12%.			



### 3.1.2.a Target Treatment Volume

The target treatment volume will ultimately determine the area of the infiltration trench. The target treatment volume is referred to in this manual as the Target Infiltration volume. This volume is a function of the contributing area, runoff coefficient, and target precipitation. The equation relating the three variables, presented for the first time in Subsection 2.1.2.a, is presented again below.

$$TIV = \frac{A * P * C}{12} \qquad \text{Equation 2.1}$$

TIV = Target Infiltration Volume (feet<sup>3</sup>)

A = Contributing Area (feet<sup>2</sup>)

P = Target Precipitation (inches), 1.1 for the 1-Year, 24-Hour Storm

C = Runoff Coefficient per Chapter 106

### 3.1.2.b Void Ratio

The function of an infiltration trench is reliant on not only the infiltration rate of the surrounding soil but also on the trench's ability to temporarily retain water. The storm water is retained within the void spaces of the storage media. The ratio of the volume of the space between individual particles of the storage media over the volume of the storage media particles is known as the void ratio. Infiltration trench storage media should consist of clean aggregate ranging from 1.5 to 3 inches in diameter. For the sake of calculation in this manual, assume a void ratio of 0.4.

### 3.1.2.c Detention Time

The retention time associated with an infiltration trench is the amount of time it takes for the full trench to discharge to the surrounding soil through the subdrain. In order to provide adequate treatment, the acceptable range for detention time is 24 to 48 hours.

### 3.1.2.d Trench Depth

The trench depth is the depth of the trench from the top surface to the bottom of the excavated area. Trench depth is a function of the design infiltration rate; the storage media void space, and the retention time. The trench depth should be between 4 and 10 feet. A minimum depth of 4 feet allows for the bottom of the trench to be at or below the frost line. Shallower depths may be permitted in non-frost susceptible soils. The equation for determining trench depth is provided below.



$$D_i = \frac{I * t}{n_s * 12} + 1 \quad \text{Equation 3.1}$$

$D_i$  = Trench Depth (feet), must be 4 to 10 feet  
 $I$  = Design Infiltration Rate (inches/hour), between 0.3 and 1 inch/hour  
 $t$  = Retention Time (hours), 24 to 48 hours  
 $n_s$  = Storage Media Void Ratio, 0.4 typical for 1.5 to 3-inch stones

The additional one foot added to the equation above is to allow for the use of a 6-inch layer of sand in the bottom of the trench and a 6-inch top layer. The sand acts to distribute flow and to reduce localized compaction when placing the storage media during construction.

#### 3.1.2.e Trench Footprint

The trench footprint is the plan view area of the trench and is a function of the design infiltration rate, the retention time, and the target infiltration volume. The equation for determining the trench footprint is provided below.

$$A_i = \frac{TIV * 0.66}{n_s * (D_i - 1)} \quad \text{Equation 3.2}$$

$A_i$  = Trench Footprint (feet<sup>2</sup>)  
 $TIV$  = Target Infiltration Volume (feet<sup>3</sup>)  
 $n_s$  = Storage Media Void Ratio, 0.4 typical for 3-inch stones  
 $D_i$  = Trench Depth (feet), between 4 and 10 feet

#### 3.1.2.f Trench Width

The width of a trench can be adjusted to meet site constraints as long as the necessary footprint area is maintained. The minimum suggested length to width ratio to be applied to an infiltration trench design is 3:1. The maximum allowable trench width, parallel to flow, is 25 feet.

### 3.1.3 Pretreatment

Infiltration trenches require pretreatment to remove large particulates. Grass filter strips are generally used to provide pretreatment for runoff entering an infiltration trench although other pretreatment devices may be used including vegetated swales, ponds, etc. At the preliminary design stage, the designer may assume a 20-foot filter strip width. For additional information on sizing filter strips for pretreatment, refer to Subsection 5.1 of this manual.



In order to assist designers in the preliminary design on an infiltration trench, a sample calculation sheet has been developed and is included in Table 5. The calculation sheet covers the above considerations and equations in six steps.

Step 1 – Calculate the Target Infiltration Volume

This step is based on Equation 2.1 presented in Subsection 3.1.2.a above, and requires the independent calculation of the runoff coefficient per Chapter 106.

Step 2 – Calculate the Depth of the Trench

This step is based on Equation 3.1 presented in Subsection 3.1.2.d above. The depth can be adjusted by adjusting the drawdown time. However, it should be noted that reductions in depth will result in increases in area.

Step 3 – Calculate the Footprint of the Trench

This step is based on Equation 3.2 presented in Subsection 3.1.2.e above.

Step 4 – Establish the Trench Length and Width

In this step, the designer may choose to set either the trench length or width to meet particular site requirements. Note that the maximum allowable trench width is 25 feet and the maximum recommended length to width ratio is 3:1.

Step 5 – Account for Pretreatment

This step involves determining the total width of the infiltration trench and associated filter strips. Note that if the site only drains to one side of an infiltration trench, only a single filter strip on that side is necessary.

Step 6 – Required Length and Width for Trench and Filter Strip

This step involves summarizing the preliminary design values for length and width established in Steps 4 and 5.



Table 5 – Infiltration Trench Preliminary Design

Site Location:		Evaluated by:	
Date:			
Step 1: Calculate the Target Infiltration Volume			Notes
Contributing Area, A		(ft <sup>2</sup> )	
Target Infiltration Rainfall, P		(in)	Set Value
Runoff Coefficient, C			Per Ch. 106
TIV = A*P*C/12 =		(ft <sup>3</sup> )	Using Equation 2.1
Step 2: Calculate the Depth of the Trench			Must be between 4 and 10 feet
Void Ratio, n <sub>s</sub>			0.4 is Typical of 1.5 to 3 in. Stone
Design Infiltration Rate, I		(in/hr)	Based on site investigation (Subsection 1.3.1 and Ch. 106)
Detention Time, t		(hr)	Must be 24 to 48 hours
D <sub>i</sub> = (I*t)/(n <sub>s</sub> *12) + 1 =		(ft)	Using Equation 3.1
Step 3: Calculate the Footprint of the Trench			
TIV (from Step 1)		(ft <sup>3</sup> )	
n <sub>s</sub> (from Step 2)			
D <sub>i</sub> (from Step 2)		(ft)	
A <sub>i</sub> = (TIV *0.66)/(n <sub>s</sub> *(D <sub>i</sub> - 1)) =		(ft <sup>2</sup> )	Using Equation 3.2
Step 4: Establish the Trench Length and Width			Minimum Recommended Ratio is 3L:1W
Set Trench Length, L <sub>i</sub>		(ft)	
Or			
Set Trench Width, W <sub>i</sub>		(ft)	Maximum Width is 25 feet
Then Calculate Either			
W <sub>f</sub> =A <sub>i</sub> /L <sub>i</sub>		(ft)	Maximum Width is 25 feet
Or			
L <sub>f</sub> =A <sub>i</sub> /W <sub>i</sub>		(ft)	
Record Final L <sub>i</sub> and W <sub>i</sub> Values			
L <sub>f</sub> =		(ft)	
W <sub>f</sub> =		(ft)	
Step 5: Account for Pretreatment			
Filter Strip Width, W <sub>f</sub>		(ft)	Minimum Recommended Width is 20 feet
If Receiving Flow From Both Sides			
Total Width (W <sub>if1</sub> ), W <sub>if1</sub> =W <sub>i</sub> + 2*W <sub>f</sub> =		(ft)	
Or, If Receiving Flow From One Side			
Total Width (W <sub>if2</sub> ), W <sub>if2</sub> =W <sub>i</sub> + W <sub>f</sub> =		(ft)	
Step 6: Required Length and Width for Trench and Filter Strip			
L <sub>f</sub> (from Step 4) =		(ft)	
Appropriate Total Width (from Step 5) =		(ft)	



Once the site evaluation and preliminary design have been completed, the final design can be performed.

#### **3.1.4 Final Design Considerations – Infiltration Trench**

In order to develop a final infiltration trench design based on the results of the preliminary design, there are several basic factors that must be addressed. Addressing these factors requires some basic understanding of engineering and hydraulic principles. At a minimum, each of the factors discussed in the subsections below should be considered during final design.

##### **3.1.4.a Filter Fabric**

Filter fabric selection and placement are important to both the effectiveness and the service life of an infiltration trench. Filter fabric should be selected that matches the infiltrative capacity of the soil in the trench to prevent clogging and piping. The fabric should be placed so that it lines the bottom and sides of the trench. Overlap between separate pieces of fabric should be a minimum of one foot. Filter fabric should also be placed below the top layer of the infiltration trench to reduce maintenance costs, since the top fabric can be cleaned or replaced much more easily than the fabric lining the bottom and sides when fine particles clog the trench.

##### **3.1.4.b Overflow Structure**

Overflow structures are important for the proper design of infiltration trenches. An overflow structure can take many forms. Examples include stand pipes discharging to an underground storm drain network, and broad crested weirs discharging to grassed ditches. No matter what kind of overflow structure is selected, it must be capable of safely transmitting runoff from the 100-year, 24-hour duration storm event so that the infiltration trench does not overtop. Overtopping may be allowed in cases where discharge due to overtopping is provided an unobstructed, safe, and non-destructive path to a conveyance system.

Any portion of an overflow structure that lies within the subgrade of an infiltration trench will reduce the volume of storm water that can be held by the trench. The trench footprint must be adjusted accordingly to account for the lost storage volume.

##### **3.1.4.c Top Layer**

Infiltration trenches can be covered with a variety of different materials. The top layer is intended to provide cover for the first layer of filter fabric and to provide a level surface that can be easily traversed. An additional benefit of the top layer is improvement of aesthetics. The top layer of an infiltration trench should consist of a minimum of 6 inches of one of the following: clean 0.5 to 1-inch crushed stone, pea gravel, or other pervious media. Due to the need for periodic maintenance, infiltration trenches should not be covered with concrete or asphalt.



#### **3.1.4.d Bottom Layer**

The bottom layer of an infiltration trench consists of 6 inches of clean sand or fine gravel. The purpose of the bottom layer is to evenly distribute flows along the bottom of the trench and to protect the underlying soil from localized compaction during placement of the storage media.

#### **3.1.4.e Grading**

Site grading is one of the most critical factors in the final design of an infiltration trench. The site must be graded so that runoff is directed to the infiltration trench evenly across the surface of the filter strips. The site must also be graded so that both the top surface and the bottom of the infiltration trench are completely level.

#### **3.1.4.f Observation Well**

An observation well is to be installed in each infiltration trench. An additional observation well shall be installed for every 50 linear feet of infiltration trench. Observation wells allow drawdown times to be monitored within the trench, and will allow maintenance crews to identify when the trench has become clogged and is in need of repair. The wells should be placed to the full depth of the trench and be secured to a footing plate. The observation well should be a minimum of 6 inches in diameter and have a waterproof locking cap at the surface.

The perforated portion of the observation well shall be between the top and bottom layers of filter fabric. Where the observation well passes through the top layer of filter fabric, the filter fabric shall be sealed around the un-perforated section of the well. This will limit the intrusion of sediments collected by the upper filter fabric into the lower portion of the well, where they are more difficult to remove.

The above list does not include every possible final design consideration. However, for most infiltration trench designs, each of the above design considerations will be necessary. Additional engineering considerations, such as the depth and location of utilities within and adjacent to the site, will be required depending on the site specific conditions.

### ***3.2 Infiltration Trench Construction and Maintenance***

#### **3.2.1 Construction Considerations – Infiltration Trench**

In addition to the minimum general considerations, discussed in Subsection 1.5, the construction of an infiltration trench requires care in the placement of the storage media. Storage media should be placed without causing compaction of the subsoil. This can be



accomplished by placing the storage media in 6-inch lifts. The storage media should not be compacted.

The minimum considerations presented in this manual do not include some typical engineering considerations such as resolving utility conflicts, and are not a substitute for sound engineering judgment.

### **3.2.2 Maintenance Considerations – Infiltration Trench**

In order to function properly over long periods of time, infiltration trenches must be maintained properly and regularly. The following are general considerations that should be addressed when developing a maintenance agreement as required by Chapter 106.

#### **3.2.2.a Watering and Weeding**

If a top layer of grass (with inlets) is used, periodic watering will be required in the first year to help the grass become established. Watering may also be required during prolonged dry periods. Weeding should be performed as necessary to maintain a healthy grassed top layer.

#### **3.2.2.b Filter Fabric**

The top layer of filter fabric in an infiltration trench will require periodic cleaning or replacement. The observation well(s) can be used to establish which portion of the filter fabric is in need of replacement. If standing water persists in the infiltration trench longer than the designed detention time, the observation well(s) should be checked. If the observation wells are empty, then the top layer of filter fabric will need to be cleaned or replaced to remove accumulated sediments. If the observation wells are full of standing water, then the storage media will need to be removed and washed, and the layer of filter fabric along the trench sides and bottom will need to be cleaned or replaced.

#### **3.2.2.c Routine Post-Storm Inspection**

Infiltration trenches and filter strips should be inspected after large rain events. The filter strips and the top layer of the infiltration trench should be inspected for evidence of erosion (which is unlikely in properly designed systems). Any visible trash accumulated on top of the infiltration trench or on the filter strip should be removed.

### **3.2.3 Infiltration Trench Conceptual Design Example**

A conceptual design example for an infiltration trench is provided in Appendix E of this manual.



## 4 Pervious Pavements

One approach to lowering the overall imperviousness of an area, while retaining necessary surfaces for fire lanes, shoulders, sidewalks, etc., is the use of porous pavement technologies. Some porous pavement technologies are not applicable in areas where sanding is common. However, other types of porous pavement can be used when adequate underdrainage, such as a sand or gravel bed, is provided. Porous pavement types suitable for application in Springdale are discussed below.

### 4.1 Types of Pervious Pavements

Open-Jointed Paving Blocks or Interlocking Concrete Pavements – These are modular paving units that allow infiltration between individual units. They are typically built over an open-graded or rapid-draining crushed stone base; with less than 3% fines passing the No. 200 sieve (see Figure 3). Perforated drainage pipes can provide drainage in heavy overflow conditions, or provide secondary drainage if the base loses some of its capacity over time. For installations where slow-draining subgrade soils are present, perforated pipes can drain excess runoff and alleviate potential for frost heaving.

**Figure 3 – Open-Jointed Paving Block**



Concrete Grids – These are perforated concrete units installed over a compacted soil subgrade, which overlies a dense-graded base of compacted crushed stone, which in turn overlies 1 to 1-1/2 inch thick bedding sand (see Figure 4). The openings in the grids are filled with either topsoil and grass or aggregate.

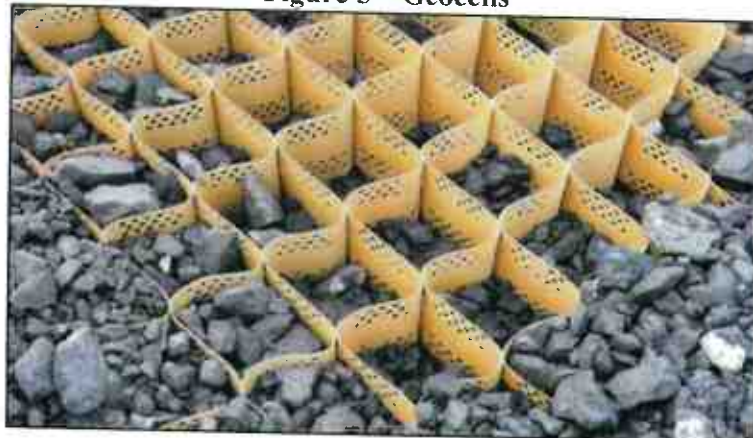


**Figure 4 – Concrete Grid**



Plastic Lattices (Geocells) – These are interlocking, high-strength blocks made from plastic materials. They provide vehicular and pedestrian load support over grass areas while protecting the grass from the harmful effects of traffic. The system is comprised of base support soil beneath the lattice unit, which is then filled with selected topsoil, and seeded with selected vegetation.

**Figure 5 – Geocells**



## **4.2 Benefits and Disadvantages**

The benefits of porous pavement technologies include the following:

- Porous pavements provide a pervious, load-bearing surface with minimal increases in imperviousness.
- Application of pervious pavement technologies can reduce site runoff and limit the degree of complexity required for storm drain design and analysis



under Chapter 106.

- In some cases, construction costs of porous pavements can be less than conventional pavements.
- Soil-enhanced turf systems are advantageous for sports and recreation fields because they resist compaction, promote infiltration, and provide a soft playing surface.

Though porous pavement technologies have a number of potential applications and benefits, there are some limitations that bear consideration. These limitations include the following:

- Sand and salt in snowmelt runoff can cause clogging of porous pavements. However, studies suggest that permeable surfaces can be used successfully, especially if they are installed properly (backfilled with clean gravel), and maintained through semi-annual vacuum cleaning.
- Construction costs of porous pavements can be higher in some cases than conventional pavement, depending on the application, and maintenance costs are usually higher.
- Most porous pavements limit wheelchair access and do not meet Americans with Disabilities Act standards, thus limiting their applicability in foot traffic areas.

Some design considerations for porous pavement are listed below.

- Assessment of site soil infiltration capacity is required to assure proper functioning of the porous pavement, which should not be installed on clayey soils or in areas of high groundwater.
- Subdrains are required for adequate drainage.
- Plant with drought tolerant turf grass (such as fescue) rather than less drought tolerant strains such as bluegrass.

#### **4.3 Design Methods for Permeable Interlocking Concrete Pavements**

For design examples, equations, and additional guidance, use the following resources:

- *Permeable Interlocking Concrete Pavements* – David R. Smith  
Fifth Edition, Published by the Interlocking Concrete Pavement Institute
- *Permeable Interlocking Concrete Pavement* – ASCE Standard 68-18  
Published by the American Society of Civil Engineers



## 5 Additional LID Elements for Consideration

### 5.1 Filter Strips

Filter strips are gently sloped, vegetated areas designed to decelerate and filter sheet flow runoff. Existing areas of dense, healthy vegetation that are capable of dispersing runoff and have experienced relatively little site disturbance or soil compaction often provide the most desirable areas for use as filter strips. These LID elements also treat total suspended solids (TSS), but they can also reduce concentrations of hydrocarbons, heavy metals, and nutrients. Filter strips remove pollutants via sedimentation, filtration, absorption, infiltration, biological uptake, and microbial activity. Depending on site characteristics such as soil type, vegetative cover, slope, and available area, filter strips can provide a modest reduction in runoff volume due to infiltration. In addition to their value as storm water treatment devices, filter strips can serve as attractive landscaping features that may incorporate a variety of trees, shrubs, and native vegetation. The simplest and often most effective filter strips are those that incorporate undisturbed existing vegetation.

The size and character of contributing drainage areas largely dictate the size and location of filter strips, since filter strips perform effectively only under sheet flow conditions, and flows tend to concentrate and have higher velocities over large or impervious drainage areas. A conceptual drawing of a filter strip is presented in Figure 6.

The advantages of filter strips include removal of sediment and insoluble contaminants from runoff, and increased infiltration of soluble nutrients and pesticides. The tall, dense vegetation of filter strips can provide a visual barrier between roads and recreation sites. Filter strips work particularly well in residential areas, providing open spaces for recreation and maintaining riparian zones along streams, which can reduce erosion and enhance animal habitats and aquatic life. In general, filter strips are simple and inexpensive to install, and have relatively few maintenance requirements. In order for filter strips to be effective, they must be properly graded to limit erosive velocities.



Figure 6 – Filter Strip Conceptual Plan and Profile

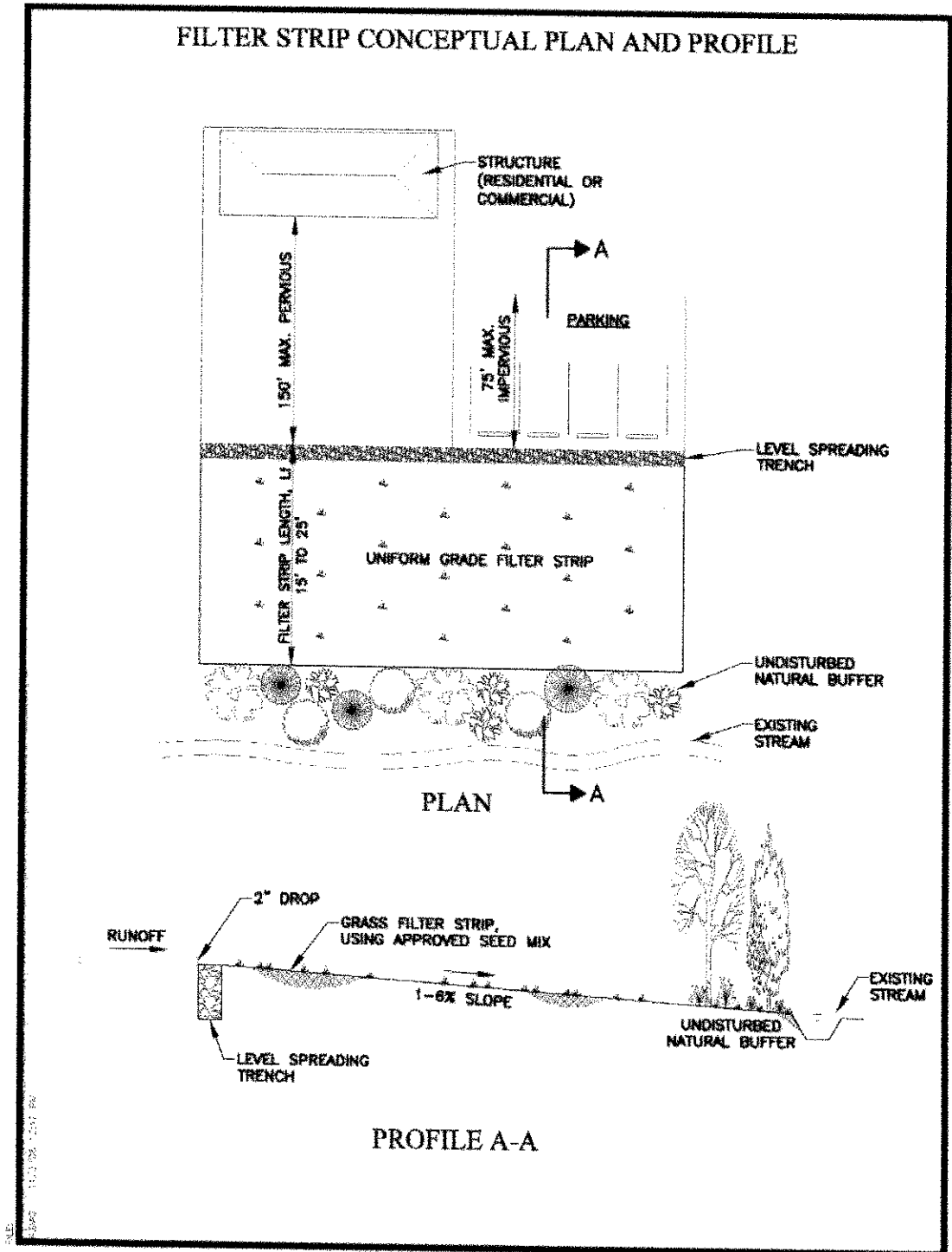


FIGURE 4



5.2 Filter Strips for Pretreatment

Filter strips are commonly used for pretreatment in association with other LID elements such as bioretention cells and infiltration trenches. Table 6 presents design guidance for slopes and lengths (parallel to flow) of pretreatment filter strips based on the slopes, dimensions, and surface characteristics of the contributing drainage areas.

Table 6 – Pretreatment Filter Strip Design Guidance

Parameter	Land Cover in Contributing Areas							
	Impervious Areas				Pervious Areas			
	35		75		75		100	
Maximum Inflow Approach Length (ft)								
Filter Strip Slope (Maximum = 6%)	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%
Minimum Filter Strip Length (ft)	10	15	20	25	10	12	15	18

5.3 The Filter Strip Design Process

The filter strip design process involves preliminary site evaluation, preliminary and final design. The following subsections present the minimum site-specific factors that are to be considered when evaluating a site for the potential use of a filter strip as primary LID elements discharging to storm water conveyance systems, natural areas, or receiving waters. These sections include a site evaluation checklist and preliminary design calculation table to guide readers through design processes for filter strips.

5.3.1 Preliminary Site Evaluation – Filter Strips

The minimum preliminary site evaluation considerations presented below do not include some typical engineering considerations such as resolving utility conflicts and are not a substitute for sound engineering judgment.

Runoff Source

Filter strips are intended to treat runoff from urban and suburban drainage areas where pollutant loads come from residential, parking, and road surface runoff. Filter strips are not appropriate to receive runoff from industrial facilities or from areas where runoff is likely to contain industrial pollutants.

Contributing Area

Filter strips are suitable to treat small drainage areas, generally one acre or less in size. It is possible to treat runoff from large areas if multiple filter strips are used. For effective performance, runoff must enter the filter strip as sheet flow. Runoff tends to concentrate within 75 feet along impervious surfaces and within 150 feet



along pervious surfaces. Longer flow paths upstream of filter strips are acceptable, but require special consideration to ensure design flows are spread evenly across the surface of the filter strips.

#### **Slope of the Contributing Area and Filter Strip**

The contributing drainage area slopes should be less than 10% for effective performance. Steeper slopes require additional energy dissipation to promote the dispersion of storm water evenly across the length of the filter strips and to prevent erosion. Slopes parallel to the flow path across filter strips should be between 1 and 6%.

#### **Available Area**

For a given site, filter strip length, parallel to the direction of flow, is dependent on slope, vegetative cover, and soil type. Generally, filter strips should extend a minimum of 15 feet in the direction of flow, with 25 feet preferred if space is available. Filter strip width, perpendicular to the direction of flow, should be equal to the width of the contributing drainage area. When filter strips are the primary LID element providing storm water treatment, the ratio of contributing area to filter strip area should not exceed 6:1.

To assist designers in the evaluation of sites for use of a filter strip, a checklist of each of the above considerations is provided in Table 9. A site must meet all of the requirements discussed in the subsections above to be a candidate for the use of a filter strip.

### **5.3.2 Preliminary Design – Filter Strips**

If the preliminary site evaluation indicates that a site is a good candidate for the use of filter strips to treat storm water, the preliminary design can proceed to establish approximate filter strip dimensions. Determining the dimensions of filter strips during preliminary design is an iterative process. There are several important considerations to be made when performing the preliminary design of a filter strip. Descriptions of the recommended preliminary design considerations are provided in the subsections below.

#### **5.3.2.1 Filter Strip Slope**

Filter strip slopes should generally range from 1% to 6% for effective performance. Slopes at the top and toe of filter strips should be as flat as possible to encourage sheet flow and prevent erosion. The maximum allowable lateral slope (perpendicular to the direction of flow) for filter strips should not exceed 1%.



Table 7 – Filter Strips – Preliminary Site Evaluation Checklist

Site Location:		Evaluated by:		
Date:				
Considerations	Requirement/Recommendation	Site Conditions/Notes	Pass/Fail	Data Source
Runoff Source	The filter strip is not to receive runoff containing industrial pollutants.			
Contributing Area	The contributing area must be less than 1 acre.			
Slope of the Contributing Area	Slope of the contributing area must be less than 10%.			
Available Area	The available area for the filter strip shall generally extend the full width of the contributing area and allow for a length (parallel to flow) of 15 to 25 feet.			
	The ratio of total contributing area to the total available area must not exceed 6:1.			

5.3.2.2 Filter Strip Flow Depths

Flow depths on filter strip surfaces should not exceed 0.5 inches. At depths greater than 0.5 inches, treatment through infiltration is reduced as deeper flows tend to push filter strip grasses parallel to the ground.

5.3.2.3 Maximum Discharge Loading

The maximum discharge load represents the maximum flow rate that can cross the threshold of a filter strip without compromising the filter strip performance. The maximum discharge loading refers to the flow entering the filter strip. The calculation of maximum discharge loading per foot width along the filter strip is based on Manning’s equation, as shown below.

$$q = \frac{1.49}{n} * \left(\frac{Y}{12}\right)^{\frac{5}{3}} * S^{\frac{1}{2}}$$

Equation 5.1

- q = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)
- Y = Maximum Allowable Depth of Flow (inches), 0.5
- S = Slope of Filter Strip (feet/foot), between 1% and 6%
- n = Manning’s “n” Roughness Coefficient, Equal to 0.2 for mowed grass and 0.25 for unmowed grass



#### 5.3.2.4 Maximum Allowable Design Velocity

The maximum allowable design velocity is the minimum allowable velocity along the filter strip under normal design conditions. The maximum allowable velocity for filter strips is 0.9 feet per second. This is based on the calculated volumetric discharge per foot width and the design flow depth. The maximum allowable design flow depth is 0.5 inches. The design velocity can be calculated using the following formula.

$$V = \frac{q}{Y/12} \quad \text{Equation 5.2}$$

V = Velocity (feet/second), 0.9 feet<sup>3</sup>/second maximum

q = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)

Y = Maximum Allowable Depth of Flow (inches), 0.5 inches maximum

#### 5.3.2.5 Minimum Allowable Filter Strip Width

The minimum width ( $W_{fp}$ ) of a filter strip, which is the dimension perpendicular to flow, is a function of flow rate entering and exiting the filter strip, according to equation shown below.

$$W_{fp} = \frac{A_a * C * 0.5}{q} \quad \text{Equation 5.3}$$

$W_{fp}$  = Width of Filter Strip Perpendicular to Flow Path (feet)

$A_a$  = Area (acres)

C = Runoff Coefficient per Chapter 106

q = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)

#### 5.3.2.6 Filter Strip Length

Filter strip length is the dimension parallel to flow. Filter strip length should be calculated for a travel time of 5 to 9 minutes according to the Soil Conservation Service (SCS) Technical Release 55 (TR-55) travel time equation (SCS, 1986) shown below.

$$L_f = \frac{T_t^{1.25} * P^{0.625} * (S * 100)^{0.5}}{3.34 * n} \quad \text{Equation 5.4}$$

$L_f$  = Length of Filter Strip Parallel to Flow Path (feet), 15 to 25 feet

$T_t$  = Travel Time through Filter Strip (minutes), 5 minutes minimum

P = Precipitation (inches) (SCS parameter used to calibrate this equation); 3.9" for the 2-Year, 24-Hour Storm

S = Slope of Filter Strip (ft/ft), 0.01 to 0.06 ft/ft



$n$  = Manning's "n" Roughness Coefficient, Equal to 0.2 for mowed grass and 0.25 unmowed grass

To assist designers in the preliminary design of a filter strip, a sample calculation sheet has been developed and is presented as Table 10. The calculation sheet covers the above considerations and equations in 4 steps.

Step 1 – Calculate the Maximum Discharge Loading

This step is based on guidance provided in Subsection 5.2.2.a and Equation 5.1 presented in Subsection 5.2.2.c above.

Step 2 – Check Velocity

This step is based on Equation 5.2 and guidance provided in Subsection 5.2.2.d.

Step 3 – Calculate the Minimum Allowable Filter Strip Width

This step is based on Equation 5.3 and guidance provided in Subsection 5.2.2.e above.

Step 4 – Calculate the Minimum Allowable Filter Strip Length

This step is based on Equation 5.4 and guidance provided in Subsection 5.2.2.f above.

Once the site evaluation and preliminary design have been completed the final design can be conducted.

### **5.3.3 Final Design – Filter Strips**

To develop a final filter strip design based on the results of the preliminary design, there are several basic factors that must be addressed. Addressing these factors requires some basic understanding of engineering and hydraulic principles. At a minimum, each of the factors discussed in the subsections below should be considered during final design.



Table 8 – Filter Strip Preliminary Design

Site Location:			Evaluated by:	
Date:				
Step 1: Calculate the Maximum Discharge Loading, q			Notes	
Maximum Allowable Depth of flow, Y		(in)	Maximum is 0.5 inches	
Slope of Filter Strip, S		(ft/ft)	Between 0.01 and 0.06	
Manning's "n"				
$q = (1.49/n) * (Y/12)^{(5/3)} * S^{(1/2)}$		(ft <sup>3</sup> /sec-ft)	Using Equation 5.1	
Step 2: Check Velocity, V			Maximum Allowable is 0.9 ft/sec	
q (from Step 1)		(ft <sup>3</sup> /sec-ft)		
Y (from Step 1)		(in)		
$V = q / (Y/12)$		(ft/sec)	Using Equation 5.2	
Step 3: Calculate the Minimum Allowable Filter Strip Width, W <sub>fp</sub>				
q (from Step 1)		(ft <sup>3</sup> /sec-ft)		
Contributing Area, A <sub>s</sub>		(acres)		
Runoff Coefficient, C			Per Ch. 106	
$W_{fp} = (A_s * C * 0.5) / q$		(ft)	Using Equation 5.3	
Step 4: Calculate the Minimum Allowable Filter Strip Length, L <sub>r</sub>				
Travel Time Through Filter Strip, T <sub>t</sub>		(min)	Between 5 and 9	
Calibration Precipitation, P		(in)	1.3 inches	
S (from Step 1)		(ft/ft)		
n (from Step 1)				
$L_r = (T_t^{1.25} * P^{0.625} * S * 100)^{0.5} / 3.34 * n$		(ft)	Using Equation 5.4	

5.3.3.1 Overall Site Integration

Site designs should incorporate filter strips as elements in the overall site plan. Filter strips can outfall to a variety of features, such as natural buffer areas, vegetated swales, curb and gutter systems, or natural drainage features.

5.3.3.2 Filter Strip Cover

Filter strip cover may consist of existing vegetation, hearty native vegetation, planted turf grasses, or a mixture of grasses and shrub vegetation. Optimal vegetation arrangements incorporate plants with dense growth patterns, fibrous root systems for stability, and adaptability to local soil and climatic conditions. Filter strips can also incorporate vegetation including sedges and flowers.



### **5.3.3.3 Level Spreading Devices**

Level spreading devices installed upstream of filter strips produce uniform sheet flow conditions along the entire leading edge of the filter strip, and help prevent concentration of flows that create erosive conditions. Level spreaders have a number of different configurations with one common function – to spread concentrated flow into sheet flow upstream of filter strips. The following examples describe common features and applications of two types of level spreading devices.

#### **Level Spreading Trench**

This device consists of a gravel-filled trench installed along the entire leading edge of a filter strip. Gravel can range in size from pea gravel, as specified by ASTM D 448, to shoulder ballast for roadways. Level spreading trenches typically have widths of 12 inches and depths of 24 to 36 inches, and they typically use nonwoven geotextile linings. A 1-inch to 2-inch drop between the adjacent impervious surface and the edge of the trench inhibits the formation of an initial deposition barrier. In addition to acting as a level spreader, these trenches also act as pretreatment devices, allowing sediment to settle out before reaching the filter strip.

#### **Natural Berms**

Shaping and grading of the area immediately upslope of a filter strip into a berm can also promote uniform sheet flow conditions. This method has a more natural appearance, though the berms can fail more readily than other devices due to irregularities in berm elevation and density of vegetation that may grow over time.

## **5.4 Filter Strip Construction and Maintenance**

### **5.4.1 Construction Considerations – Filter Strips**

The following subsections summarize the minimum considerations to be made during construction to enhance the effectiveness and function of filter strips. These construction considerations are not all necessarily applicable when using existing undisturbed areas as filter strips.

#### **5.4.1.1 Filter Strip Installation**

Before beginning construction, install temporary erosion and sediment control measures and ensure that upgradient sites have stabilized slopes. Install the filter strips during a time of year when successful establishment of vegetation can occur with little or no irrigation, and use temporary irrigation during dry periods. Clear and grub the site as necessary for filter strips that incorporate planted rather than native vegetation. During installation, disturb as little existing vegetation as possible and avoid soil compaction.



#### **5.4.1.2 Grading and Level Spreader Installation**

Accurate grading must occur during the construction of filter strips, because even small departures from design slopes can affect sheet flow conditions and decrease filter strip effectiveness. Use the lightest, least disruptive equipment when rough grading slopes to avoid excessive compaction and land disturbance. Following the rough grading, install level spreading devices at the upgradient edges of filter strips. If using a gravel trench, do not compact the subgrade and follow the construction sequence for infiltration trenches.

#### **5.4.1.3 Vegetation Establishment**

Seeding should be performed immediately after grading. Simultaneously stabilize seeded filter strips with temporary techniques such as erosion control matting or blankets. Maintain erosion control for seeded filter strips for at least 75 days following the first storm event of the season.

### **5.4.2 Maintenance Considerations – Filter Strips**

The application of regular maintenance procedures enables filter strips to function properly over long periods of time. The following subsections outline suggestions for consideration when developing a maintenance plan and schedule as required by this policy.

#### **5.4.2.1 Soil**

In areas where heavy metals deposition is likely, it is recommended that soils should be removed and replaced once every 20 years. Replacing soil in filter strips is likely to provide a prolonged service life. When replacing soil in filter strips, refer to recommendations for engineered soils in bioretention cells provided in Appendix C of this manual.

#### **5.4.2.2 Watering and Weeding**

Periodic watering is required in the first year to help grass become established. Watering may also be required during prolonged dry periods. Weeding should be performed as necessary to maintain a healthy grassed top layer.

#### **5.4.2.3 Routine Post--Storm Inspection**

Filter strips should be inspected after large rain events and should be inspected for evidence of erosion, which is not likely in properly designed systems. Any visible trash accumulated on the filter strips should be removed.

#### **5.4.2.4 Vegetation Maintenance**

Basic maintenance of filter strips involves normal landscaping maintenance activities such as mowing, trimming, removal of invasive species, and replanting when necessary. Filter strips receiving large amounts of sediment may require



periodic regrading and reseeding of their upslope edges. If a high volume of sediment builds up, creating concentrated flows and channels, filter strips may require reworking or replanting. Grass should be maintained at a length of 3 to 8 inches. Allowing grass to grow taller can cause thinning, which compromises the effectiveness of the vegetative cover. The removal of clippings and regular maintenance promotes vegetation growth and pollutant uptake.

#### **5.4.3 Filter Strip Conceptual Design Example**

A conceptual design example for a filter strip is provided in Appendix E of this manual.



## 6 Glossary of Selected Terms

*Freeboard* – The vertical distance between the level water surface and the lowest point along the top of a structure, such as a berm, that impounds or restrains the water.

*Zone of Influence* – The zone of influence refers to the area of the surrounding subgrade that is critical to proper function and support of the overlying and/or adjacent foundation or road subgrade. Generally, the zone of influence can be defined as the area bounded within a 3-dimensional surface extending at a 1:1 slope down and away from the outer edge of a foundation or road subgrade.

*Catchment Area* – In this document, catchment area refers to the total area contributing storm water runoff to a particular LID element.

*Cleanout* – A cleanout is an access point in a buried storm drain conveyance to allow periodic removal of any collected sediment or debris.

*Keyed In* – The phrase “keyed in” refers to the condition in which the top edge of a geotextile (impervious or pervious) is folded into the surrounding soil to keep the material from slipping downward over time.

*Foot Plate* – A foot plate is a plate that can be round or rectangular, and is fixed to the bottom of an observation well. The intent of the foot plate is to provide a foundation for the observation well and prevent any vertical movement. Generally, foot plates should be either plastic or metal with the shortest dimension being twice the length of the diameter of the observation well.

*Hydrologic Soil Group D* – Soils with a very low rate of water transmission (less than 0.06 in/hr) (NRCS, 2007).

*Runoff Coefficient* – Rational Method Runoff Coefficient calculated according to guidance contained in Chapter 106.

*Subdrain* – A system of underground perforated pipes which are used to collect water that has infiltrated through the soil in a bioretention cell and transmit it to an underground conveyance.

*Underground Conveyance* – This term refers to a system of underground storm drain pipes which convey storm water, such as pipes within the existing municipal separate storm sewer system.



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## **Appendix A**

### **Equations**



**Equation 2.1: Target Treatment Volumes for Bioretention cells**

$$TIV = \frac{A * P * C}{12}$$

Equation 2.1

TIV = Target Infiltration Volume (feet<sup>3</sup>)  
A = Contributing Area (feet<sup>2</sup>)  
P = Target Precipitation (inches)  
C = Runoff Coefficient per Chapter 106

**Equation 2.2: Bioretention cell Footprint**

$$A_r = \left( \frac{12 * TIV}{P_d} \right) * (0.26 * I_e^{-0.53})$$

Equation 2.2

A<sub>r</sub> = Bioretention cell Footprint (feet<sup>2</sup>)  
TIV = Target Infiltration Volume (feet<sup>3</sup>)  
P<sub>d</sub> = Depth of Pondered Water (inches)  
I<sub>e</sub> = Infiltration Rate of Engineered Soils (inches/hour)

**Equation 2.3: Total Depth for Bioretention cells**

$$D_{rs} = \frac{P_d + F_d}{12} + E_d + S_d + 0.005 * L_r$$

Equation 2.3

D<sub>rs</sub> = Total Depth of Bioretention cell with Subdrain (feet)  
P<sub>d</sub> = Depth of Pondered Water (inches)  
F<sub>d</sub> = Freeboard (inches)  
E<sub>d</sub> = Depth of the Engineered Soils (feet)  
S<sub>d</sub> = Depth Required for Subdrain Diameter and Drain Rock (feet)  
L<sub>r</sub> = Approximate Length of Bioretention cell Along the Axis of the Subdrain (feet)



**Equation 3.1: Trench Depth**

$$D_i = \frac{I * t}{n_s * 12} + 1$$

*Equation 3.1*

$D_i$  = Trench Depth (feet)  
 $I$  = Design Infiltration Rate (inches/hour)  
 $t$  = Retention Time (hours)  
 $n_s$  = Storage Media Void Ratio

**Equation 3.2: Trench Footprint**

$$A_i = \frac{TIV * 0.66}{n_s * (D_i - 1)}$$

*Equation 3.2*

$A_i$  = Trench Footprint (feet<sup>2</sup>)  
 $TIV$  = Target Infiltration Volume (feet<sup>3</sup>)  
 $n_s$  = Storage Media Void Ratio  
 $D_i$  = Trench Depth (feet)

**Equation 5.1: Filter Strip Maximum Discharge Loading**

$$q = \frac{1.49}{n} * \left( \frac{Y}{12} \right)^{\frac{5}{3}} * S^{\frac{1}{2}}$$

*Equation 5.1*

$q$  = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)  
 $Y$  = Allowable Depth of Flow (inches)  
 $S$  = Slope of Filter Strip (feet/foot)  
 $n$  = Manning's "n" Roughness Coefficient

**Equation 5.2: Maximum Allowable Design Velocity**

$$V = \frac{q}{\frac{Y/12}{12}}$$

*Equation 5.2*

$V$  = Velocity (feet/second)  
 $q$  = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)  
 $Y$  = Maximum Allowable Depth of Flow (inches)



**Equation 5.3: Minimum Allowable Filter Strip Width**

$$W_{fp} = \frac{A_a * C * 0.5}{q}$$

*Equation 5.3*

$W_{fp}$  = Width of Filter Strip Perpendicular to Flow Path (feet)  
 $A_a$  = Area (acres)  
 $C$  = Runoff Coefficient per Chapter 106  
 $q$  = Volumetric Discharge per Foot Width (feet<sup>3</sup>/second-foot)

**Equation 5.4: Filter Strip Length**

$$L_f = \frac{T_t^{1.25} * P^{0.625} * (S * 100)^{0.5}}{3.34 * n}$$

*Equation 5.4*

$L_f$  = Length of Filter Strip Parallel to Flow Path (feet)  
 $T_t$  = Travel Time through Filter Strip (minutes)  
 $P$  = Target Precipitation (inches)  
 $S$  = Slope of Filter Strip (ft/ft)  
 $n$  = Manning's "n" Roughness Coefficient

**Equation D.1: Weir Equation for Flow into Standpipe or Riser**

$$Q = N_s * G * C_w * P_s * H^{3/2}$$

*Equation D.1*

$Q$  = Flow Rate, (feet<sup>3</sup>/second)  
 $N_s$  = Number of Outfall Structures  $G$  = Grate Reduction Factor  
 $C_w$  = Weir Coefficient  
 $P_s$  = Perimeter of the Stand Pipe (feet)  $H$  = Head (feet)

For the design of LID elements in this manual, the weir coefficient can be assumed as 3.3. Grate reduction factors are available from various grate manufacturers. For preliminary planning purposes, a value of 0.5 may be used.



**Appendix B**  
**Additional Specifications for**  
**Bioretention Cells**



**Table B.1 – Vegetation Suitable for Bioretention cells in Springdale**

Native perennial flowers, grasses, and shrubs that prefer or tolerate moist soils should thrive in a rain garden or bioswale. They'll also entice butterflies, hummingbirds, and other nectar and berry feeders to visit. These local plants tend to be well-adapted to a range of regional temperature and moisture conditions and will flourish without chemical fertilizers and pesticides.

### **Perennials and Herbaceous Plants**

**Amsonia**, *Amsonia sp.*  
**Bushy Aster**, *Aster dumosus*  
**Heath Aster**, *Aster ericoides*  
**New England Aster**, *Aster novae-anglia*  
**Beardtongue**, *Penstemon digitalis* 'Huskers Red'  
**Black-eyed Susan**, *Rudbeckia fulgida* 'Goldstrum'  
**Blazing Star**, *Liatris spicata* 'Kobod'  
**Narrowleaf Blue Star**, *Amsonia hubrichtii*  
**Cardinal Flower**, *Lobelia peciose*  
**Carolina Lovegrass**, *Eragrostis pectinacea*  
**Catmint**, *Nepeta cataria* 'Walker's Low'  
**Wild Columbine**, *Aquilegia canadensis*  
**Christmas Fern**, *Polystichum acrostichoides*  
**Northern Maidenhair Fern**, *Adiantum Pedatum*  
**Sensitive Fern**, *Onoclea sensibilis*  
**Rough Goldenrod**, *Solidago rugosa*  
**Hypericum**, *Hypericum profificum*  
**Hyssop**, *Agastache rupestris*  
**Blue Flag Iris**, *Iris veriscolor*  
**Jack-in-the-pulpit**, *Arisaema triphyllum*  
**Sweet Joe-Pye Weed**, *Eupatorium Purpureum*  
**Milkweed**, *Asclepias*  
**Torrey's Mountain Mint**, *Pycnanthemum Virginianum*  
**Obedient Plant**, *Physotegia virgniana*  
**Ornamental Grass**, *Miscanthus sinensis* 'Adagio' and 'Little Kittens'  
**Ponytail Grass**, *Stipa tenuissima*  
**Striped Rush**, *Baumea rebiginos* 'Variegata'  
**Russian Sage**, *Perovskia atriplicifolia*  
**Golden Tickseed**, 'Coreopsis tinctoria

### **Shrubs and Vines**

**American Arborvitae**, *Thuja occidentalis*  
**Rosebud Azalea**, *Rhododendron periclymenoides*  
**Northern Bayberry**, *Myrica pensylvanica*  
**Highbush Blueberry**, *Vaccinium corymbosum*



Late Lowbush Blueberry, *Vaccinium angustifolium*  
 Butterfly Bush, *Buddleia davidii*  
 Red Chokeberry, *Aronia arbutifolia*  
 Black Chokeberry, *Aronia melanocarpa*  
 Red Twig Dogwood, *Cornus sericea*  
 Elderberry, *Sambucus Canadensis*  
 American Holly, *Ilex opaca*  
 Winterberry Holly, *Ilex verticillata*  
 Trumpet Honeysuckle, *Lonicera sempervirens*  
 Black Huckleberry, *Gaylussacia baccata*  
 Inkberry, *Ilex glabra*  
 Mountain Laurel, *Kalmia latifolia*  
 Nannyberry, *Viburnum lentago*  
 Sweet Pepperbush, *Clethra alnifolia*  
 Northern Spicebush, *Lindera benzoin*  
 Bluebeard Spirea, *Caryopteris x Clandonensis*  
 Shining Sumac, *Rhus copallinum*  
 Virginia Creeper, *Parthenocissus quinquefolia*  
 Prairie Willow, *Salix humilis*

### Trees

Green Ash, *Fraxinus pennsylvanica*  
 White Ash, *Fraxinus Americana*  
 Gray Birch, *Betula populifolia*  
 River Birch, *Betula nigra*  
 Blackgum, *Nyssa sylvatica*  
 Red Cedar, *Juniperus virginiana*  
 Red-Panicked Dogwood, *Cornus racemose*  
 Elm, *Ulmus glabra 'Camperdownii'*  
 American Hop Hornbeam, *Ostrya virginiana*  
 Sweet Bay Magnolia, *Magnolia virginiana*  
 Red Maple, *Hacer rubrum*  
 Pawpaw, *Asimina spp.*  
 Pin Oak, *Quercus palustris*  
 Red Oak, *Quercus rubra*  
 Redbud, *Cercis canadensis 'Oklahoma'*  
 Sassafras, *Sassafras albidium*  
 Serviceberry, *Amelanchier arborea*  
 American Sweetgum, *Liquidambar styraciflua*  
 Tupelo, *Nyssa sylvatica*  
 Witch Hazel, *Hammamelis virginiana*  
 Swamp White Oak, *Quercus bicolor*  
 Dwarf Yaupon Holly, *Ilex vomitoria 'Nana'*



### **Additional Guidance for the Specification of Engineered Soils for Bioretention cells**

The following bulleted list is intended to assist designers in specifying an engineered soil mix for use in a bioretention cell. Soil specifications may vary slightly depending on site characteristics and related design considerations.

- The final soil mix (including compost and soil) should have a long-term hydraulic conductivity of approximately 1.0 inch/hour according to ASTM Designation D 2434 (Standard Test Method for Permeability of Granular Soils) at 80% compaction per ASTM Designation D 1557 (Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort). Note that infiltration rate and hydraulic conductivity are assumed to be approximately the same in a uniform mix soil.
- The final soil mixture should have a minimum organic content of 10% by dry weight per ASTM Designation D 2974 (Standard Test Method for Moisture, Ash and Organic Matter of Peat and Other Organic Soils).
- The final soil mixture should be tested by an independent laboratory prior to installation for fertility, micronutrient analysis, and organic material content. Soil amendments per laboratory recommendations (if any) should be uniformly incorporated for optimum plant establishment and early growth.
- The clay content of the final soil mix should be less than 5%.
- The pH for the soil mix should be between 5.5 and 7.0. If the pH falls outside of the acceptable range, it may be modified with lime to increase the pH or iron sulfate plus sulfur to lower the pH. The lime or iron sulfate must be mixed uniformly into the soil prior to use in the bioretention cell.
- Soil mix should be uniform and free of stones, stumps, roots, or other similar material greater than 2 inches in diameter.

Unless laboratory analysis indicates otherwise, engineered soils are to be assigned a design infiltration rate of 1.0 inches/hour during design efforts. This value is consistent with a moderately high saturated hydraulic conductivity.



**Appendix C**  
**Bioretention Cell Design Example**



**C. Design Example – Bioretention cell**

This section presents the design process for a bioretention cell to treat runoff from the parking area of the site described below.

Site Description – *A 1.8-acre lot in midtown Anchorage is to be redeveloped. The existing lot contains an old warehouse and a large parking area. The redeveloped lot will include a three-story office building a landscaped garden and a parking area. The new parking lot will contain approximately 0.75 acres of paved surface. Bioretention cells have been identified as a good alternative for treating runoff from the parking area, since a bioretention cell can be designed to serve as the required site landscaping as well. The preliminary site design has included an area within the center of the parking facility to place the bioretention cell.*

In the following subsections a preliminary site evaluation and a preliminary design are presented for the design of a bioretention cell for this site. Following these sections, a final design is discussed and a conceptual drawing of the final design is presented.

**C.1 Example Preliminary Site Evaluation – Bioretention cell**

To conduct the preliminary site evaluation, the preliminary site evaluation checklist (Table 2) provided in Section 2 has been used. To fill out the preliminary site evaluation checklist, the following reference materials were required:

- The draft preliminary site plans,
- Springdale stormwater network maps
- Local topographic maps, and
- The site geotechnical report.

Prior to conducting the preliminary site evaluation, it was noted that due to the close proximity of the bioretention cell to the parking lot subgrade, the use of a 30-mil polyethylene liner is required. This information was incorporated into the preliminary site evaluation.

The completed preliminary site evaluation checklist is presented as Table C.1. The information presented in Table C.1 indicates that the site is likely suitable for the use of a bioretention cell to treat parking lot runoff. However, review of the geotechnical report indicates that the groundwater table is located at a depth of 9 feet below grade. Based on the site evaluation, it was not certain that it would be possible to maintain the minimum separation distance between the bottom of the lined bioretention cell and the groundwater table (2 feet for lined bioretention cells). The groundwater table would limit the total depth of the bioretention cell to no more than 7 feet. This has been noted and is to be addressed during the preliminary design.



**Table C.1 – Bioretention cell – Preliminary Site Evaluation Checklist**

<b>Site Location:</b> 1112 W 100th Street <b>Evaluated by:</b> William H. Seward						
<b>Date:</b> 8/24/2012						
Considerations	Applies to Lined Bioretention cell?	Applies to Bioretention cells with Subdrains?	Requirement/Recommendation	Site Conditions /Notes	Pass /Fail	Data Source
Soil Infiltration	Y	N	Measured soil infiltration rate must be between 0.3 and 8 in/hr.	The lowest soil infiltration rate in the area being considered for the rain garden is 1.0 in/hr.	Pass	Geotechnical Report
Proximity to Surface Waters	N	Y	Bioretention cell should be located at least 100 feet from surface waters.	There are no surface waters within 100 feet of the site.	Pass	Topo Map
Depth to Seasonal High Groundwater Level	Y	Y	4 feet or more below the top of an unlined bioretention cell and 2 feet or more below the top of a lined bioretention cell.	Groundwater is 9 feet below the proposed grade near the bioretention cell.	Investigate Further	Geotechnical Report
Depth To Bedrock	N	Y	Bedrock must be 3 foot or more below the bottom of a bioretention cell.	Bedrock was not encountered; drilling went to a depth of 15 feet below grade.	Pass	Geotechnical Report
Proximity to Building Foundations	N	Y	Bioretention cell must be located outside of the zone of influence or at least 20 feet from building foundations.	The garden will be located approximately 60 feet from the nearest foundation.	Pass	Preliminary Site Plans
Proximity to Road Subgrades	N	Y	Bioretention cell must be located outside of the zone of influence or at least 20 feet from road subgrades.	Bioretention cell will be located within parking lot. A liner will need to be used.	Pass	Preliminary Site Plans
Runoff Source	Y	Y	Bioretention cell is not to receive runoff containing industrial pollutants.	Runoff is from a parking lot.	Pass	Preliminary Site Plans
Contributing Area	Y	Y	The contributing area must be less than 5 acres.	Area contributing to the garden is 0.75 acres.	Pass	Preliminary Site Plans
Available Area Slope	Y	Y	The slope must be less than or equal to 5%.	Proposed site slopes are 0.5%.	Pass	Preliminary Site Plans
Available Area	Y	Y	The area available for treatment must be at least 10% of the total contributing area.	Adequate space is available.	Pass	Preliminary Site Plans
Down Gradient Slope	N	Y	Average slope of adjacent down gradient property must be less than 12%.	The grade of the adjacent downgradient lot is less than 2%.	Pass	Topo Map



## **C.2 Example Preliminary Design – Bioretention cell**

During the preliminary design process the minimum design considerations presented in Subsection 2.1.2 must be addressed. In order to conduct the preliminary bioretention cell design, the preliminary design calculation table (Table 3) presented in Section 2 has been used. The completed preliminary design calculations are presented in Table C.2.

In Step 1 of the preliminary design calculations, the runoff coefficient has been obtained from Chapter 106. The slope of the parking lot is less than 2% resulting in a runoff coefficient of 0.85. The calculation in Step 1 indicates that the bioretention cell will need to accommodate a volume of approximately 2,546 feet<sup>3</sup> of runoff.

In Step 2 of the preliminary design calculations the maximum ponding depth is selected to limit the amount of required area for the bioretention cell. Also the minimum horizontal to vertical side slope is used to minimize the area required for the bioretention cell. The resulting area required to contain the bioretention cell is 993 feet<sup>2</sup>. It was determined by the design team that a square garden placed in the center of the parking lot would be preferable. Thus, in Step 2 the dimensions of the bioretention cell were calculated to be approximately 32 feet by 32 feet.

In Step 3, use Equation 2.3 to estimate the depth of the bioretention cell. The minimum ponded depth and minimum soil depth were both assumed to limit the total depth of the bioretention cell. The depth required for the subdrain was assumed to be 1.75 feet. This accounts for a 3– inch layer of drain rock under the subdrain, an 8–inch diameter subdrain, a 6–inch layer of drain rock above the subdrain, and a 4–inch layer of pea gravel above the drain rock. The resulting estimated total depth of the bioretention cell is 5.2 feet.



Table C.2 – Bioretention cell Preliminary Design

Site Location: 1112 W 10 <sup>th</sup> Street			Evaluated by: Don Sheldon	
Date: 8/24/2012				
Step 1: Calculate the Target infiltration Volume, TIV			Notes	
Contributing Area, A	32670	(ft <sup>2</sup> )	Approximate Parking Lot Area	
Target infiltration Rainfall, P	1.1	(in)	Set Value	
Runoff Coefficient, C	0.85		Per Ch. 106	
TIV = A*P*C/12 =		2546	(ft <sup>3</sup> )	Using Equation 2.1
*Step 2: Calculate the Required Bioretention cell Footprint Area				
TIV (from Step 1)	2546	(ft <sup>3</sup> )		
Depth of Poned Water, P <sub>d</sub>	8.0	(in)	Maximum of 8 inches	
Design Infiltration Rate, I <sub>e</sub> (or I, see Subsection 2.1.2.c)	1.0	(in/hr)	1.0 for engineered soils	
$A_r = (TIV * 12 / P_d) (0.26 * I_e)^{-0.53}$		993	(ft <sup>2</sup> )	Using Equation 2.2
Approximate Width, W <sub>r</sub>	W <sub>r</sub> = A <sub>r</sub> / L <sub>r</sub> =		32	(ft)
Approximate Length, L <sub>r</sub>	L <sub>r</sub> = A <sub>r</sub> / W <sub>r</sub> =		32	(ft)
Step 3: Approximate Bioretention cell Depth				
P <sub>d</sub> (From Step 2)	8.0	(in)		
Freeboard Depth, F <sub>d</sub>	2	(in)	Minimum of 4 inches	
Depth of Engineered Soils, E <sub>d</sub>	2.5	(ft)	Minimum of 2.5 feet	
Minimum Subdrain Depth, S <sub>d</sub>	1.75	(ft)		
L <sub>r</sub> (From Step 3)	32	(ft)		
$D_{rs} = (P_d + F_d) / 12 + E_d + S_d + (0.005 * L_r) =$		5.2	(ft)	Using Equation 2.3
Note: *See Appendix C for guidance on selecting a value for I <sub>e</sub>				



The results of the preliminary site evaluation and the preliminary design indicate that the site is a suitable candidate for the use of a bioretention cell to treat storm water runoff from the parking lot. Thus, final design efforts are warranted.

### **C.3 Example Final Design – Bioretention cell**

To develop the final design based on the dimensions calculated in the preliminary design, the minimum factors presented in Subsection 2.1.3 were addressed. In real world applications, the final design of a bioretention cell is likely to include slight adjustments in geometry and will likely include site related engineering considerations specific to the particular project. For the sake of this example, the dimensions calculated in the preliminary design have been directly applied to the final design.

**Engineered Soils** – The specifications for the engineered soils are based on the requirements presented in Subsection 2.1.3.a, the guidance provided in Appendix C, and the geotechnical investigation for the site. The geotechnical investigation for the site indicates that the native soils are primarily loamy sand. Thus, approximately 60% of the excavated native soil will be set aside and mixed with compost to provide engineered soil for the bioretention cell.

**Bioretention cell Plants** – The specification for the bioretention cell plants is based on the guidance provided in Subsection 2.1.3.b and the listing of suggested bioretention cell plants provided in Appendix C. The interior of the garden is to be planted with Red Twig Dogwood and Willow. The interior of the garden will also be planted with Native Sedge grass.

**Subdrain System** – The subdrain system has been designed according to the guidance provided in Subsection 2.1.3.c. The subdrain system includes a branched network of 8-inch slotted PVC pipes. The PVC drainpipe sits atop a 3-foot wide bed of drain rock that is 3 inches thick. The drainpipe is overlaid with drain rock to a depth of 6 inches above the pipe. The drain rock is covered with 4 inches of pea gravel to reduce the likelihood of clogging. Note that backflow preventers have been included to keep the bioretention cell subsoil from becoming saturated when the storm drains become surcharged.

**Bioretention cell Liner** – The bioretention cell is lined with 30-mil polyethylene plastic with welded joints. The liner is keyed into the sides of the bioretention cell to prevent it from slipping downward over the course of time.

**Overflow Structure** – The overflow structure selected for the bioretention cell consists of two standpipes located along the center axis of the bioretention cell. The standpipes are connected to an underground storm drain that has been sized for the 100-year, 24-hour storm according to the Rational Method and guidance in Chapter 106. In this case, a 100-year peak flow rate of 0.7 feet<sup>3</sup>/second was estimated based on a time of concentration of 15 minutes, an intensity of 1.1 inches per hour, and a weighted C value of 0.85 inch. The standpipes were initially sized to meet the diameter of the underground conveyance system for the



sake of convenience. The standpipe sizes were then checked for the maximum overtopping depth of 2 inches using the following inlet weir equation below.

$$Q = N_s * G * C_w * P_s * H^{3/2} \qquad \text{Equation C.1}$$

- Q = Flow Rate, (feet<sup>3</sup>/second)
- N<sub>s</sub> = Number of Structures, 2
- G = Grate Reduction Factor, 0.5
- C<sub>w</sub> = Weir Coefficient, 3.3
- P<sub>s</sub> = Perimeter of the Stand Pipe (feet), 7.85
- H = Head (feet), 0.167

Thus, when the ponded depth of the bioretention cell is 2 inches above the top of the standpipes, the standpipes will be conveying 1.8 feet<sup>3</sup>/second of runoff. This exceeds the peak runoff from the 100-year 24-hour storm. The 30-inch diameter standpipes are adequately sized for flood control according to Chapter 106.

A conceptual drawing of the bioretention cell resulting from this design effort is presented in Figure C.1.

This bioretention cell will significantly reduce the runoff peak that exits the site during large rain events. It also provides treatment for the full TIV.



**Figure C.1 – Bioretention cell Design Example**  
**Page 1**

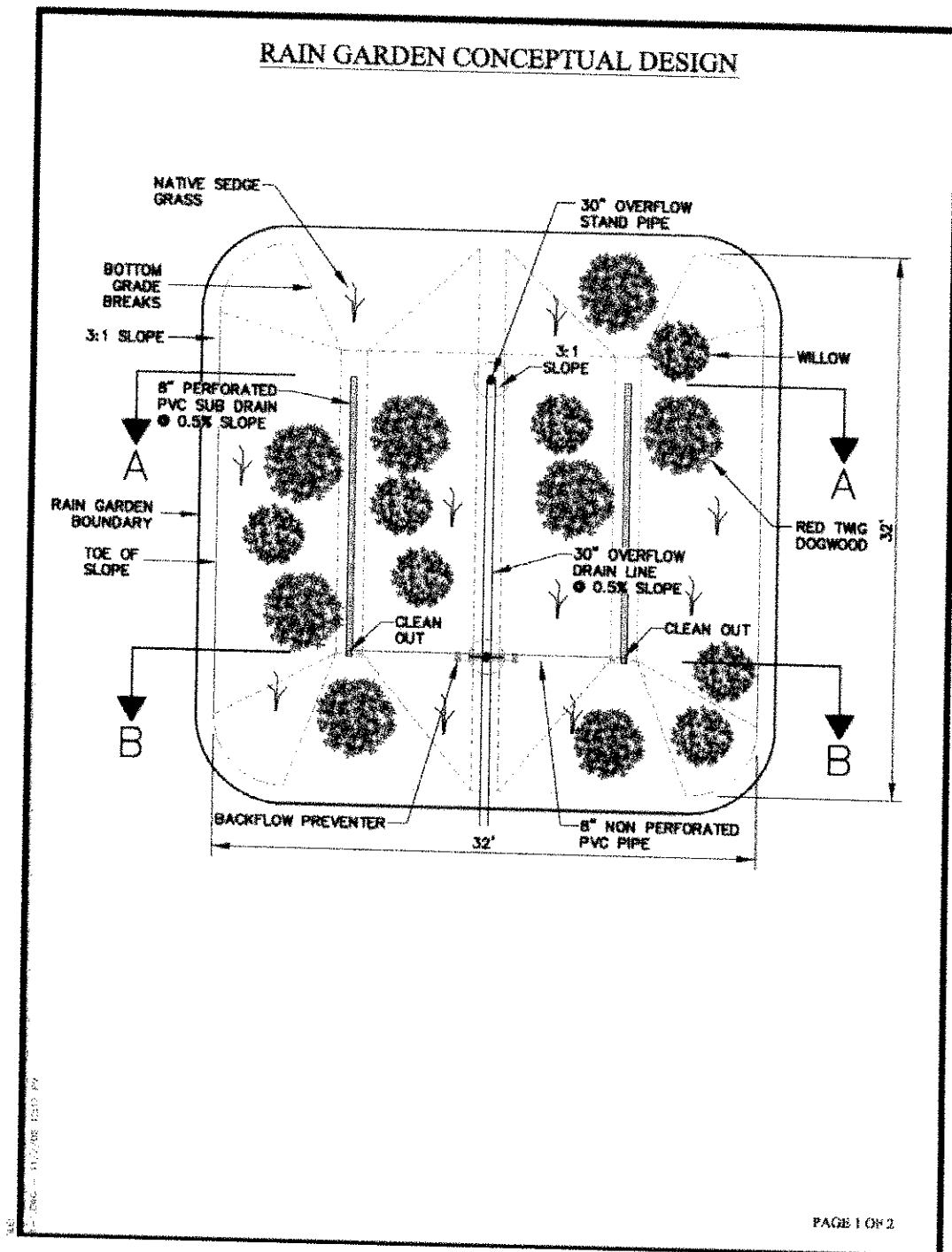
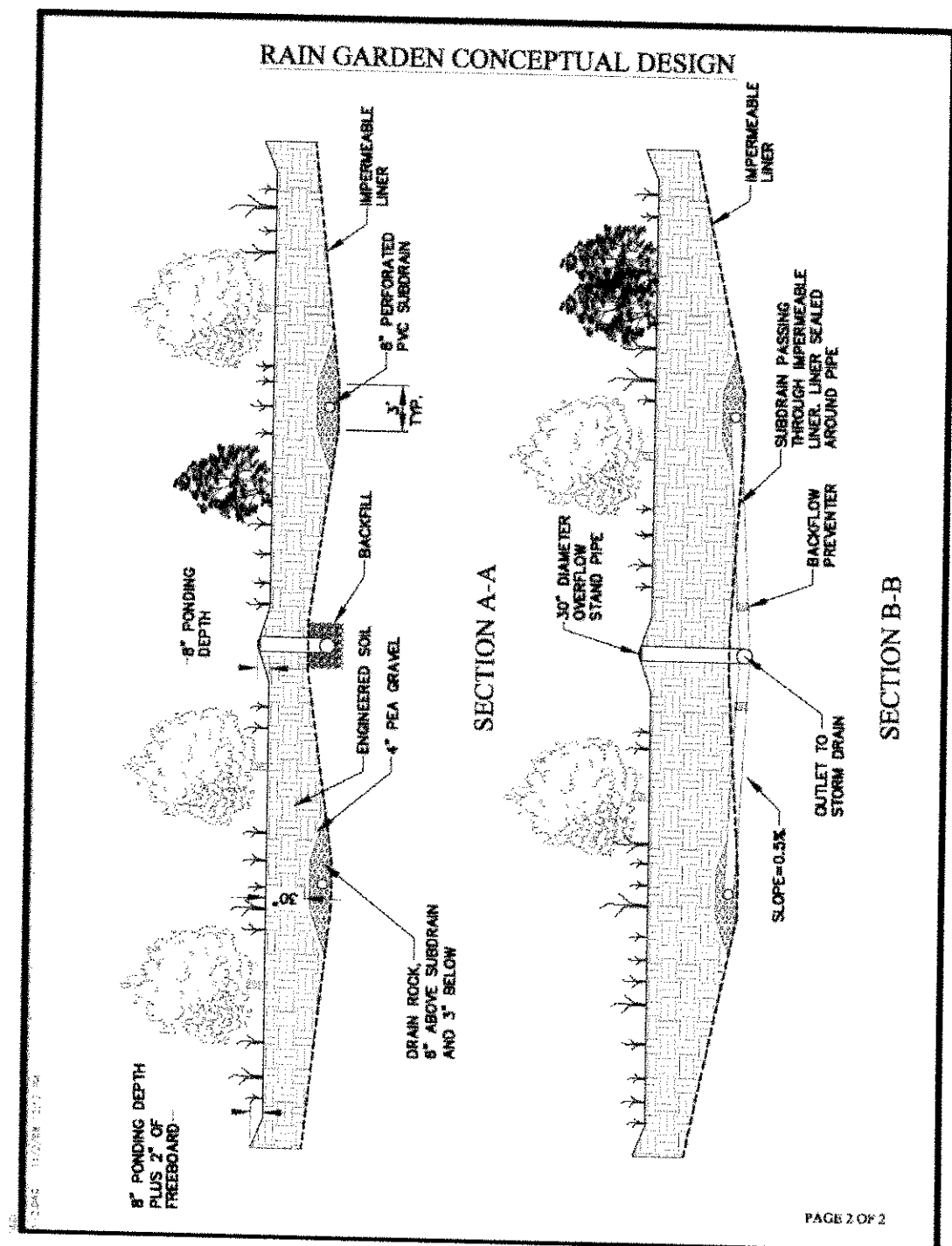




Figure C.1 – Bioretention cell Design Example  
Page 2





**Appendix D**  
**Infiltration Trench Design Example**



## **D Design Example – Infiltration Trench**

This section presents the design process for an infiltration trench to infiltrate parking lot runoff from a portion of the site described below.

Site Description: *An 8-acre tract of relatively flat land is to be developed into an apartment complex. The complex will include four separate three-story apartment buildings each containing 12 two-bedroom apartments. The development will include a 32 space parking lot for each building as well as open green space to be used for landscaping and recreation. The developer would like to incorporate LID elements to infiltrate runoff from the base 2-year, 24-hour storm event. Infiltration trenches have been identified as a potential option to infiltrate runoff from the parking areas. Each parking lot is approximately 65 feet by 140 feet. The available space for an infiltration trench at each parking lot is approximately 40 by 65 feet.*

In the following subsections, a preliminary site evaluation and a preliminary design are presented for an infiltration trench for a single parking lot. Following these sections, a final design is discussed and a conceptual drawing of the final design is presented.

### **D.1 Example Site Evaluation – Infiltration Trench**

In order to conduct the preliminary site evaluation, the preliminary site evaluation checklist (Table 4) provided in Section 3 has been used. To fill out the preliminary site evaluation checklist, the following reference materials were required:

- The draft preliminary site plans,
- Water and Wastewater Utility Maps,
- Local topographic maps, and
- The site geotechnical report.

The completed preliminary site evaluation checklist is presented as Table D.1. The information presented in Table D.1 indicates that the site is likely suitable for the use of an infiltration trench to treat parking lot runoff. However, review of the preliminary site plan indicates that the infiltration trenches will be limited to a length of no more than 65 feet due to the parking lot layout. The preliminary site evaluation also indicates that groundwater is at a depth of 8 feet, thus limiting the allowable depth of an infiltration trench to no more than 4 feet.

Other than these considerations, the site is a good candidate for the use of an infiltration trench to treat runoff from the parking lot. The limitations in the possible trench dimensions have been noted and are addressed during the preliminary design.



**Table D.1 – Infiltration Trench – Preliminary Site Evaluation Checklist**

<b>Site Location:</b> 1112 W 100th Street		<b>Evaluated by:</b> Leonhard Seppala		
<b>Date:</b> 8/24/2010				
Considerations	Requirement/Recommendation	Site Conditions/Notes	Pass/Fail	Data Source
Soil Infiltration Rate	Measured soil infiltration rate must be between 0.3 and 8 in/hr.	The lowest soil percolation rate in the area being considered for the trench is 0.3 in/hr.	Pass	Geotechnical Report
Proximity to Surface Waters	Trench should be located at least 100 feet from surface waters.	There are no open surface waters within 200 feet of the site.	Pass	Topo Map
Depth to Seasonal High Groundwater Level	Groundwater must be 4 feet or more below the bottom of the trench.	Groundwater is 8 feet below the surface. Need to know how deep trench will be.	Investigate Further	Geotechnical Report
Depth To Bedrock	Bedrock must be 3 feet or more below the bottom of the trench.	Bedrock is at a depth of 10 ft. Need to know how deep the trench will be.	Investigate Further	Geotechnical Report
Proximity to Building Foundations	Trench must be located outside of the zone of influence or at least 20 feet from building foundations.	Trenches will be located more than 20 feet from building foundations	Pass	Draft Preliminary Site Plans
Proximity to Road Subgrades	Trench must be located at least 20 feet from road subgrades.	It is anticipated that there will be adequate room to place the trenches a minimum of 20 feet from road subgrades.	Pass	Draft Preliminary Site Plans
Runoff Source	Infiltration trench is not to receive runoff containing industrial pollutants.	Parking Area	Pass	Draft Preliminary Site Plans
Contributing Area	The contributing area must be less than 3 acres.	The approximate contributing area is 0.2 acres.	Pass	Draft Preliminary Site Plans
Available Area Slope	Available area slope must be less than or equal to 5%.	The average slope of the contributing area is 0.5%.	Pass	Draft Preliminary Site Plans
Available Area	The area available for treatment must be at least 20% of the total catchment area.	Approximately 40% of the total site area will consist of open space for lawns and landscaping.	Pass	Draft Preliminary Site Plans
Down Gradient Slope	Down gradient slope must be less than 12%.	The adjacent properties are also gently sloping.	Pass	Site Visit/Topo Map



## **D.2 Example Preliminary Design – Infiltration Trench**

In order to conduct the preliminary infiltration trench design, the table (Table 5) presented in Section 3 has been used. The completed preliminary design calculations are presented in Table E.2.

In Step 1 of the preliminary design calculations, the runoff coefficient, 0.85, has been obtained from Chapter 106. The calculation in Step 1 indicates that the infiltration trench will need to accommodate a volume of approximately 709 feet<sup>3</sup> of runoff.

In Step 2, the typical void ratio was assumed. A retention time of 48 hours was assumed. The resulting trench depth is 4 feet. This depth will still accommodate the minimum separation distance between the bottom of the infiltration trench and the groundwater table.

In Step 3, the bottom area of the trench is calculated based on values collected and calculated in Steps 1 and 2. The required bottom area of the trench is 390 feet<sup>2</sup>.

In Step 4, the length and width of the trench is established. The infiltration trench will receive sheet flow from the parking lot along the side that is 35 feet long. Thus, the length of the infiltration trench has been set in Step 4 to be 35 feet. The resulting required width of the infiltration trench (not counting the pretreatment area) is 11.1 feet.

In Step 5, the width required for an infiltration trench receiving runoff from a single side and from both sides is calculated. Note that the infiltration trench will only receive runoff from one side. The resulting width is 31.1 feet.

In Step 6, the length selected in Step 4 is recorded with the width calculated in Step 5 for infiltration trench receiving runoff from one side. These values represent the required area for the infiltration trench.

The results of the preliminary site evaluation and the preliminary design indicate that the site is a suitable candidate for the use of an infiltration trench to treat storm water runoff. Thus, final design efforts are warranted.



Table D.2 – Infiltration Trench Preliminary Design

Site Location: 1112 W 100th Street			Evaluated by: Don Sheldon		
Date: 8/24/2012					
Step 1: Calculate the Target Infiltration Volume, TIV				Notes	
Contributing Area, A	9100	(ft <sup>2</sup> )		Total Contributing Area	
Target Infiltration Rainfall, P	1.1	(in)		Set Value	
Runoff Coefficient, C	0.85			Per Ch. 106	
$TIV = A * P * C / 12 =$	709	(ft <sup>3</sup> )		Using Equation 2.1	
Step 2: Calculate the Depth of the Trench, D <sub>i</sub>				Must be between 4 and 10 feet	
Void Ratio, n <sub>s</sub>	0.4			0.4 is Typical of 1.5 to 3 in. Stone	
Design Infiltration Rate, I	0.3	(in/hr)		Based on site investigation (Subsection 1.3.1 and Ch. 106)	
Detention Time, t	48	(hr)		Must be 24 to 48 hours	
$D_i = (I * t) / (n_s * 12) + 1 =$	4	(ft)		Using Equation 3.1	
Step 3: Calculate the Bottom Footprint of the Trench					
TIV (from Step 1)	709	(ft <sup>3</sup> )			
n <sub>s</sub> (from Step 2)	0.4				
D <sub>i</sub> (from Step 2)	4	(ft)			
$A_i = (TIV * 0.66) / (n_s * (D_i - 1)) =$	390	(ft <sup>2</sup> )		Using Equation 3.2	
Step 4: Establish the Trench Length and Width				Minimum Recommended Ratio is 3L:1W	
Set Trench Length, L <sub>i</sub>	35.0	(ft)			
Or					
Set Trench Width, W <sub>i</sub>		(ft)		Maximum Width is 25 feet	
Then Calculate Either					
$W_i = A_i / L_i$	11.1	(ft)		Maximum Width is 25 feet	
Or					
$L_i = A_i / W_i$		(ft)			
Record Final L <sub>i</sub> and W <sub>i</sub> Values					
L <sub>i</sub> =	35.0	(ft)			
W <sub>i</sub> =	11.1	(ft)			
Step 5: Account for Pretreatment					
Filter Strip Width, W <sub>f</sub>	20.0	(ft)		Minimum Recommended Width is 20 feet	
If Receiving Flow From Both Sides					
Total Width (W <sub>if1</sub> ), W <sub>if1</sub> = W <sub>i</sub> + 2 * W <sub>f</sub> =		(ft)			
Or, If Receiving Flow From One Side					
Total Width (W <sub>if2</sub> ), W <sub>if2</sub> = W <sub>i</sub> + W <sub>f</sub> =	31.1	(ft)		Receiving flow from a single side	
Step 6: Required Length and Width for Trench and Filter Strip					
L <sub>1</sub> (from Step 4) =	35.0	(ft)			
Appropriate Total Width (from Step 5) =	31.1	(ft)		Receiving flow from a single side	



**D.3 Example of Final Design – Infiltration Trench**

In order to develop the final design based on the dimensions calculated in the preliminary design, the minimum factors presented in Subsection 3.1.4 were addressed. In real world applications, the final design of an infiltration trench is likely to included slight adjustments in geometry as well as site related engineering considerations specific to the particular project.

**Filter Fabric** – To reduce the likelihood of clogging and piping, a filter fabric has been specified with a flow rate to closely match the surrounding soils’ infiltration rate of 0.3 feet/sec. The fabric is placed between the storage media and the trench walls and overlaps by 1-foot long seams. It is placed as a barrier beneath the 6 inches of top material. Filter fabric is placed between the top layer and the storage media. The fabric will be keyed into the sides of the trench walls.

**Design of the Overflow Structure** – The overflow structure of choice for this particular example is the use of standpipes at the trench boundaries. These structures are connected to a storm drain trunk line that runs down the adjacent road. The standpipes were initially sized to meet the diameter of the underground conveyance system (12 inches) for the sake of convenience. The standpipe sizes were then checked for an overtopping depth of 3 inches as depths greater than 3 inches would result in stormwater spilling beyond the limits of the trench and overflow structures.

$$Q = N_s * G * C_w * P_s * H^{\frac{3}{2}}$$

Equation D.1

- Q = Flow Rate, (feet<sup>3</sup>/second)
- N<sub>s</sub> = Number of Structures, 2
- G = Grate Reduction Factor, 0.5
- C<sub>w</sub> = Weir Coefficient, 3.3
- P<sub>s</sub> = Perimeter of the Stand Pipe (feet), 3.14
- H = Head (feet), 0.25

When the ponded depth of the infiltration trench is 3 inches above the top of the standpipes, the standpipes will be conveying 1.3 feet<sup>3</sup>/second of runoff. This exceeds the peak runoff from the 100-year 24-hour storm according to a rational calculation. The 12-inch diameter standpipes are therefore adequately sized for flood control according to Chapter 106.

**Top Layer** – The material selected for this application is washed pea gravel. The pea gravel will be laid in a 6-inch layer on top of the filter fabric that overlies the storage media.

**Bottom Layer** – The bottom layer consists of washed filter sand.



**Grading** – The site grading plan has been completed so that the parking lot will sheet drain across the filter strip to the infiltration trench. The trench has been graded to be completely level along the top and bottom.

**Observation Well** – The infiltration trench includes two 6 inch observation wells that can be seen in Figure D.1.

A drawing of the infiltration trench is presented as Figure D.1. Note that in this design, the area required for the structure is slightly larger than the area estimated using the preliminary design calculations. This is due to the use of overflow inlets on either end of the infiltration trench and the 3:1 (horizontal: vertical) side slope.



Figure D.1 – Infiltration Trench Design Example

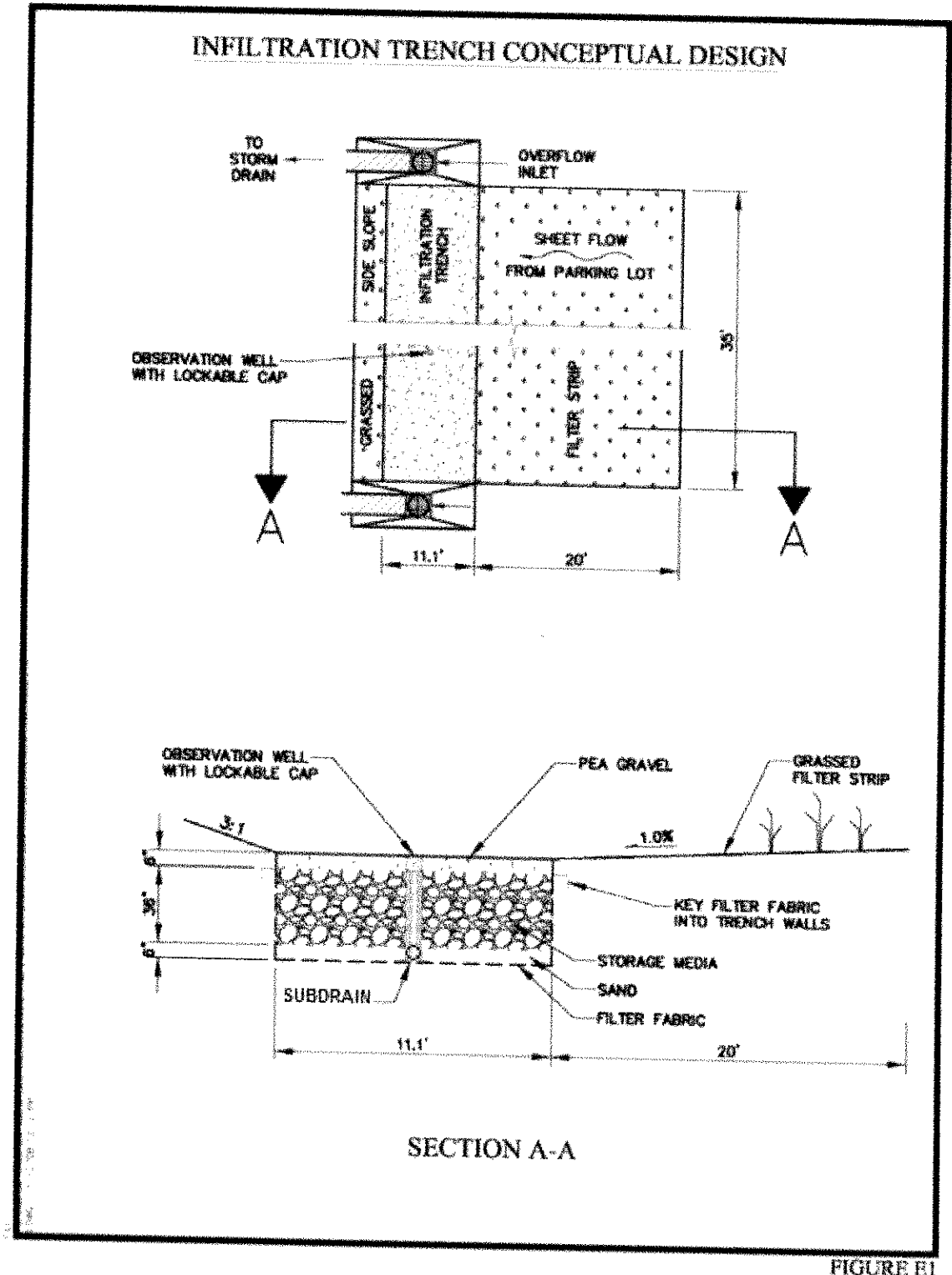


FIGURE B1



**Appendix E**  
**Filter Strip Design Examples**



## ***E. Filter Strip Design Example***

This section presents the design process for a filter strip to infiltrate parking lot runoff from a portion of the site described below.

Site Description: *A small commercial strip development will include a parking area to accommodate 20 vehicles. The site presently drains towards a frontage street into a curb and gutter storm drain system. The area available for the parking lot is 200 feet long by 65 feet wide. A filter strip is proposed to treat runoff from the parking area prior to discharge to the curb and gutter system along the frontage street. Making the assumption that the filter strip will be approximately 25 feet long (dimension parallel to flow) the parking area will be approximately 200 feet by 40 feet.*

In the following subsection, the preliminary site evaluation and a preliminary design are presented for a filter strip for the parking lot. Following these sections, a final design is discussed and a conceptual drawing of the final design is presented.

### **E.1 Example Preliminary Site Evaluation – Filter Strips**

In order to conduct the preliminary site evaluation, the preliminary site evaluation checklist (Table 8) provided in Section 5 has been used. To fill out the preliminary site evaluation checklist, the draft preliminary site plans were required.

The completed preliminary site evaluation checklist is presented as Table E.1. The information presented in Table E.1 indicates that the site is suitable for the use of a filter strip to treat parking lot runoff.



Table E.1 – Filter Strip – Preliminary Site Evaluation Checklist

Site Location: 1115 W 100th Street		Evaluated by: Aldo Leopold		
Date: 8/24/2010				
Considerations	Requirement/Recommendation	Site Conditions / Notes	Pass/Fail	Data Source
Runoff Source	Filer strip is not to receive runoff containing industrial pollutants.	Runoff is from a parking lot.	Pass	Draft Preliminary Site Plans
Contributing Area	The contributing area must be less than 1 acre.	Contributing area is approximately 0.18 acres.	Pass	Draft Preliminary Site Plans
Slope of the Contributing Area	Slope of the contributing area must be less than 10%.	The parking lot will have a slope much less than 10%	Pass	Draft Preliminary Site Plans
Available Area	The available area for the filter strip shall generally extend the full width of the contributing area and allow for a length (parallel to flow) of 15 to 25 feet.  The ratio of total contributing area to the total available area must not exceed 6:1.	Site provides adequate space for a filter strip. The available area for the filter strip (200 feet by 25 feet) is more than 1/6th the size of the contributing parking lot (200 feet by 40 feet).	Pass	Draft Preliminary Site Plans



## **E.2 Example Preliminary Design – Filter Strips**

In order to conduct the preliminary filter strip design, the preliminary design calculation table (Table 8) presented in Section 5 has been used. The completed preliminary design calculations are presented in Table E.2.

In Step 1, of the preliminary design calculations, the maximum allowable depth of flow is assumed, the design slope is set to 3%, and a Manning's "n" of 0.25 is selected for dense grass. The calculation in Step 1 indicates that the filter strip will be able to accommodate 0.005 feet<sup>3</sup>/sec runoff for every linear foot of width (the dimension perpendicular to flow).

In Step 2, the velocity along the filter strip is checked by dividing the maximum discharge loading by the design depth. According to the calculations in Step 2, the design velocity is 0.12 feet/second, which is equal to the maximum allowable velocity.

In Step 3, the minimum allowable filter strip width is calculated. The rational coefficient in this computation is selected based on guidance provided in Chapter 106. The results of the computation in Step 3 indicate that the minimum allowable width for the filter strip is 15.3 feet. This is much less than the available width of 200 feet. Therefore, the preliminary design proceeds to Step 4.

In Step 4, the minimum allowable filter strip length (dimension parallel to flow) is calculated. In this step, a travel time of 5.5 minutes was selected. According to the computations in Step 3, the minimum allowable filter strip length is 21.0 feet. This is approximately equal to the assumed length of 25 feet. Thus, final design efforts are warranted.



Table E.2 – Filter Strip Preliminary Design

Site Location: 1112 W 100th Street			Evaluated by: Don Sheldon
Date: 8/24/2012			
Step 1: Calculate the Maximum Discharge Loading, q			Notes
Maximum Allowable Depth of flow, Y	0.5	(in)	Maximum is 0.5 inches
Slope of Filter Strip, S	0.03	(ft/ft)	Between 0.01 and 0.06
Manning's "n"	0.25		
$q=(1.49/n)*(Y/12)^{(5/3)}*S^{(1/2)}$	0.005	(ft <sup>3</sup> /sec-ft)	Using Equation 5.1
Step 2: Check Velocity, V			Maximum Allowable is 0.9 ft/sec
q (from Step 1)	0.005	(ft <sup>3</sup> /sec-ft)	
Y (from Step 1)	0.5	(in)	
$V=q/(Y/12)$	0.12	(ft/sec)	Using Equation 5.2
Step 3: Calculate the Minimum Allowable Filter Strip Width, W <sub>fp</sub>			
q (from Step 1)	0.005	(ft <sup>3</sup> /sec-ft)	
Contributing Area, A <sub>a</sub>	0.18	(acres)	
Runoff Coefficient, C	0.85		Per Ch. 106
$W_{fp}=(A_a*C*0.5)/q$	15.3	(ft)	Using Equation 5.3
Step 4: Calculate the Minimum Allowable Filter Strip Length, L <sub>f</sub>			
Travel Time Through Filter Strip, T <sub>t</sub>	5.5	(min)	Between 5 and 9 Minutes
Target Precipitation, P	1.3	(in)	1.3 inches
S (from Step 1)	0.03	(ft/ft)	
n (from Step 1)	0.25		
$L_f=(T_t^{1.25}*P^{0.625}*(S*100)^{0.5})/3.34*n$	21.0	(ft)	Using Equation 5.4



### **E.3 Example Final Design – Filter Strips**

In order to develop the final design based on the dimensions calculated in the preliminary design, the minimum factors presented in Subsection 5.2.3 were addressed. In real world applications, the final design of a filter strip is likely to include slight adjustments in geometry and will likely include site related engineering considerations specific to the particular project. For the sake of the example, the dimensions calculated in the preliminary design have been directly applied to the final design discussed below.

**Overall Site Integration** – The existing site did not offer the opportunity to use areas of existing vegetation as filter strips. The existing site offers enough space to meet the desired parking area with additional room for a well designed and constructed filter strip that can sheet drain to an existing curb and gutter system. The filter strip has been placed lengthwise between the frontage road and the new parking area. The parking area has been graded to sheet drain to the filter strip. However, because the parking spaces require parking stops, which will concentrate flows upstream of the filter strip, the design has incorporated a level spreading device.

**Filter Strip Cover** – The selected filter strip cover in this design is Schedule C seed mix. This grass will require little maintenance and will provide a natural appearance to the site. The application rate is 5 lbs/1,000 square feet.

**Level Spreading Devices** – As mentioned previously, a level spreading device is required in this design. The device selected is a gravel-filled trench. The trench is 12 inches wide by 24 inches deep. It is lined with a non-woven geotextile material and has a 1 inch drop along its leading edge.

A conceptual plan and profile drawing of the filter strip resulting from this design effort is presented in Figure E.1. This design will provide treatment for the first flush from rainfall events.



Figure E.1 – Filter Strip Conceptual Plan and Profile

