Planning Commission Staff Report

MEETING DATE: September 13, 2022
SUBJECT: Creation of the Heber City Storm Water Design Manual
RESPONSIBLE: Russell Funk, City Engineer
DEPARTMENT: Engineering **FILE NO:** 21015
STRATEGIC RELEVANCE:
- Principles: Necessary Administrative Action
-Goals: 2) Infrastructure Sustainability

SUMMARY

The purpose of this item is to present a proposed Heber City Storm Water Design Manual, receive input from the Planning Commission and the public, and to seek recommendation for approval by Ordinance to the City Council.

RECOMMENDATION

1. Hold a public hearing and consider public comments on the proposed changes.
2. Consider and recommend approval of the Heber City Storm Water Design Manual to the City Council for approval by Ordinance.

BACKGROUND

Heber City has established design criteria and regulations for public and private storm water management systems within the city. However, those criteria and regulations are in various places in the City Code, Master Plan Documents, and in the Engineering Standard Specifications and Drawings. In addition, the existing design criteria and regulations are not updated relative to State storm water regulations to which Heber City will eventually be subject.

This Heber City Storm Water Design Manual brings all of those design criteria and regulations into one document and expounds upon and incorporates some of the upcoming State storm water regulations. It also provides standard methodologies to facilitate uniformity in both the preparation and review of the storm water aspects of development applications.

DISCUSSION

Attached to this report is the Heber City Storm Water Design Manual. It is divided into sections that address submittals requirements and the various aspects of a storm water management system. These include: rainfall, runoff, conveyance, storage, discharge, water quality, and low-impact development.

FISCAL IMPACT

None

CONCLUSION

This Heber City Storm Water Manual will:

- Bring all storm-water-related information into one document,

75 N. Main St. ● Heber City, Utah 84032● (435) 654-0757 ● ci.heber.ut.us

- Better prepare the City for upcoming State regulations,
- Facilitate the preparation of development applications by developers and their engineers, and
- Facilitate the review of development applications by City staff.

ALTERNATIVES
None

POTENTIAL MOTIONS

Staff Recommended Option - Approval
"I move to forward a positive recommendation of this item as presented to the City Council for Adoption by Ordinance."

Alternative 1 - CONTINUANCE
"I move to Continue this item to ___Date___ , with direction to Staff on information and/or changes needed to render a decision, as follows: …"

Alternative 2 - DENIAL
"I move to Deny this item with the findings described as follows: …"

ACCOUNTABILITY

Department: Engineering
Staff Member: Russell Funk, City Engineer

EXHIBITS / ATTACHMENTS

Proposed Heber City Storm Water Design Manual

HEBER CITY

HEART OF THE WASATCH BACK

HEBER CITY STORM WATER DESIGN MANUAL

Heber City Engineering

DRAFT

SEPTEMBER 8, 2022

HEBER CITY
75 N Main Street
Heber City, UT 84032

Contents

Introduction 1
Purpose of document 1
Definitions 1
Approval Procedure 2
Preliminary Drainage Plan and Report 2
Final Drainage Plan and Report 2
Design Standards and Analysis Methods 3
Design Storms for Conveyance 3
Storage Facilities 4
Storm Drain System Hydraulic Requirements 5
Channel Hydraulic Requirements 5
Above Ground Storage Basins (Ponds) 5
Culverts 6
Roadway Drainage 6
Rainfall Runoff Computation Methods 7
Post Construction Peak Discharge 8
Infiltration 9
Low Impact Development 9
Vegetated Swales 10
Dry Swales 10
Wet Swales 10
Infiltration Basin/Galleries 11
Rain Gardens 11
Water Quality 12
Pre-treatment and Treatment Systems 12
Water Quality Control Measures 15
Source Protection 15
Natural Channels 16
Flood and Debris Flow Hazards 16
FEMA Flood Analysis 16
Debris-Flow Flood Hazard Analysis 16
Appendices 19

Introduction

Purpose of document

The purpose of this document is to establish design standards and guidelines for storm drainage infrastructure within Heber City. This document also promotes uniformity among development design submittals and drainage reports.

The design criteria in this document are for use on public and private projects within the city. There are other adopted City documents that also reference requirements related to storm drain systems within the city. These documents include the Heber City Standard Specifications and Drawings, the Heber City Master Plans, and the Heber City Municipal Code. This document is designed to work in collaboration with these other stated references, however, in the case of discrepancies the more stringent standard will apply. All requirements and the intent of design requirements in this document shall be met unless otherwise approved by the City Engineer.

Definitions

cfs	*Cubic feet per second (449 gallons per minute)*
Ac-Ft	*Acre-foot (volume of water required to cover an acre of land to a depth of one foot)*
Detention	*Short term storage of runoff provided by a pond or similar facility. An outlet is provided that allows water to be released from the facility at a predetermined rate.*
LID	*Low Impact Development is an approach to improving water quality by reducing the amount of storm runoff generated by a project and relying on infiltration or evaporation to handle runoff where it is generated.*
Retention	*Long term storage of storm water provided by a pond or similar facility that does not allow water to be discharged. Water will stay in a retention pond after a storm event until it either evaporates or infiltrates into the bottom of the pond.*

DRAFT

Approval Procedure

Preliminary Drainage Plan and Report

i. A preliminary drainage plan and report are required for all site plan and subdivision developments within the city. The preliminary drainage plan must include the following as applicable:
    1. Existing topography (2-foot contours or finer) extending at least 100 feet beyond the site
    2. Existing drainage infrastructure and features
    3. Existing drainage and gravity irrigation channel/canal features
    4. Watershed delineations and existing drainage patterns/flow paths
    5. Proposed drainage infrastructure and features (onsite and offsite)
    6. Proposed drainage patterns/flow paths
ii. The preliminary drainage report must include the following as applicable:
    1. Introduction
    2. Project Scope
    3. Project Location
    4. Description of Existing Conditions
    5. Drainage Design Criteria
    6. Off-Site Watershed Drainage and Hydrology
        a. Preliminary Upstream/Downstream Flood Analysis
        b. Preliminary Hazards & Debris-Flow Analysis
    7. On-Site Area Drainage and Hydrology and Hydraulics
    8. LID features
    9. Detention and/or Retention Facilities
    10. Water Quality Features (e.g., LID, HDS, pretreatment etc.)
    11. Major Stream Crossings
    12. Non-pressurized Irrigation Systems

Final Drainage Plan and Report

iii. Final drainage plans and report are required for all site plan and subdivision developments within the City shall be submitted after acceptance/approval of the preliminary submittal. The final drainage report shall be submitted for review prior to final site plan or subdivision approval.
iv. Final Drainage Plans must include the following as applicable:
    1. Existing and proposed topography (2-foot contours or finer) extending at least 100 feet beyond the site
    2. Existing drainage infrastructure and features
        a. Onsite features (channels, flow control, etc.)
        b. Offsite features (debris basins, etc.)
    3. Existing drainage and gravity irrigation channel/canal features
    4. Watershed delineations and existing drainage patterns/flow paths
    5. Location of all proposed drainage features
        a. Onsite features (channels, flow control, etc.)
        b. Offsite features (debris basins, etc.)

6. Proposed drainage patterns/flow paths
7. Proposed drainage details
8. Improvements to city facilities
9. LID, water quality and retention features

v. Final Drainage Report must include as applicable:
1. Introduction
2. Project Scope
3. Project Location
4. Detailed Description of Existing Conditions
5. Drainage Design Criteria
6. Off-Site Drainage and Hydrology with Final Calculations
    a. Final Upstream/Downstream Flood Analysis
    b. Final Hazards & Debris-Flow Analysis
    c. Recommended Mitigation
7. On-Site Drainage Hydrology and Hydraulics with Final Calculations
8. Description of LID Measures
    a. Justification for products selected and why they are most appropriate
    b. Compliance with on-site retention rules
9. Detailed Description of Detention and/or Retention Facilities
10. Major Stream Crossing
11. Non-pressured Irrigation Systems
12. Permanent Erosion Control Features
13. Water Quality Features (e.g., LID, HDS, pretreatment etc.)
14. Storm Drain System Calculations

All plans and reports are subject to review and approved by Provo River Watershed Council. See Appendix A for list of resources for drainage design in Heber City.

Design Standards and Analysis Methods

These standards apply to all developments within Heber City including the North Village area or other areas that may annex into the City in the future. Heber City may establish additional storm drain design criteria for certain development areas through a new Storm Drain Master Plan and/or Master Plan update. All developments shall comply with the City Storm Drain Master Plan that is applicable for the respective development.

Design Storms for Conveyance

New developments within Heber City must have an initial and a major storm drain system for storm water conveyance. The initial system's purpose is to reduce the frequency of street flooding, reduce maintenance costs, and provide protection against regularly recurring damage from storm runoff. The initial conveyance system must handle the 10-year storm event at a duration equal to or less than the time of concentration (T_c), and typically consists of pipe, storm drain inlets, curb and gutter, or drainage swales that convey the storm water.

The purpose of the major conveyance system is to avoid major property damage or loss of life during flood level runoff conditions. The major system is comprised of the initial conveyance system elements but also includes the entire roadway cross section, including park strip and sidewalk, or other safe surface routes. The major system must protect against flooding during the 100-year storm event at a duration equal to or less than the T_c.

Every effort shall be made to keep the major system above ground. But, where that is impractical, the City Engineer may approve the major system to be underground if it is designed for it from the top of the catchment. “Funneling” at the bottom of a catchment is not allowed. The following figure details how the initial and major systems must function.

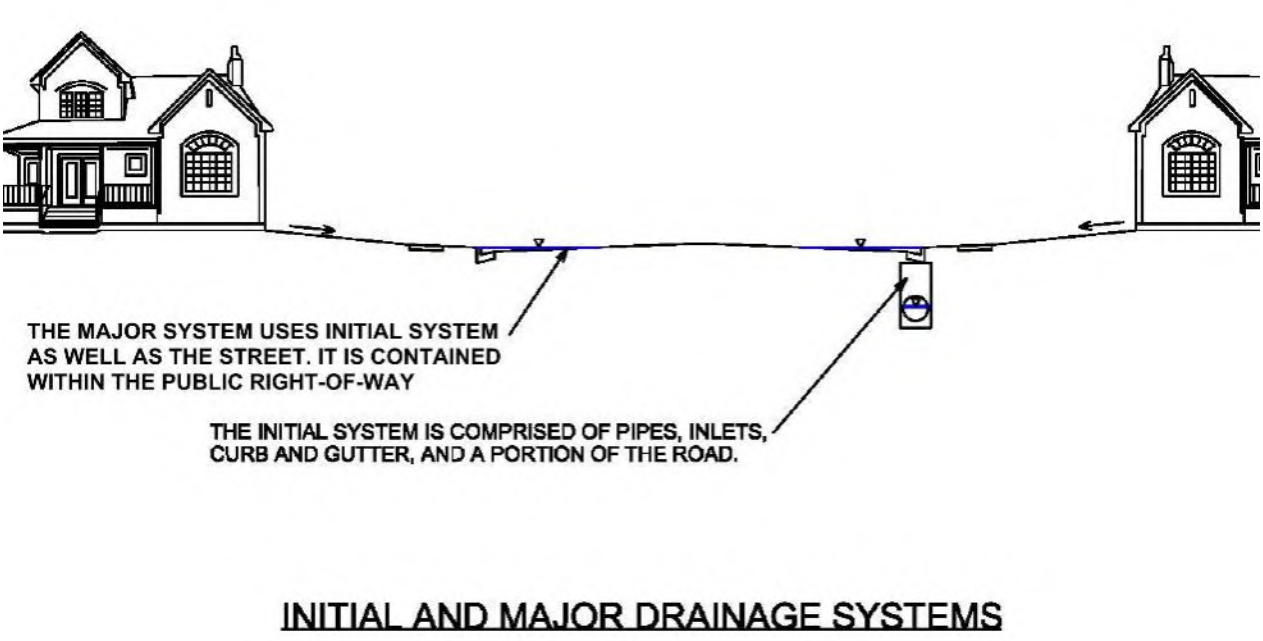


Figure 1. Initial and Major Drainage Systems

Directly connected impervious areas should be independent watershed basins and should not be combined and averaged with pervious areas.

Storage Facilities

Storm drain storage facilities are required for flood control and water quality purposes. Storage facilities may be above ground basins/ponds or below ground storage systems. Detention storage facilities require an approved suitable discharge location approved by the City Engineer. Retention facilities are required when no suitable discharge location is available. Detention facilities must be designed to store and detain the 25-year event with a maximum release rate of the lesser of 0.1 cfs/acre or historic flows in the 2-year, 10-year and 25-year events. See the Post Construction Peak Discharge section for more detailed requirements. Retention storage facilities must provide retention volume for the 100-year, 24-hour event. Infiltration may be considered as outflow when sizing retention facilities. See the section on

Infiltration in this document for details regarding infiltration requirements. However, if infiltration is utilized for facility sizing design, shorter storm durations with higher intensities must be checked (i.e., rational spreadsheet), and the controlling or largest volume, minus the infiltration, shall be used to size the storage facility. Therefore, the 24-hour storm may not result in the largest storage volume. When utilizing the SCS Type II 24-hour storm for sizing storage facilities with infiltration, the storm distribution must provide a peak intensity where the majority of the rainfall occurs during a shorter period of time.

Storm Drain System Hydraulic Requirements

Pipe systems used for conveyance must be designed such that they flow unpressurized during the required design event. Minimum pipe diameter for public storm drain pipes within City right-of-way is 18 inches but may be reduced to 15 inches for pipes from a single inlet box. Private storm drain pipe may be reduced to 10 inches but must still adhere to conveyance design storm requirements. Pipe material must adhere to Heber City Standard Specifications and Drawings. Junction boxes or manholes should be placed such that the maximum pipe length between two structures does not exceed 400 feet.

Apply an inlet clogging factor of 30% for inlets on grade and 50% for inlets in sags.

The minimum pipe slopes shall be pursuant to HEC 22 Table 7-7. The n-values shall be 0.012 for plastic pipe and 0.013 for concrete pipe.

On steeper slopes, provide a sufficient number of inlets to reduce inlet bypass to less than 0.2 cfs and to reduce risk of water sweeping pedestrians off their feet.

Design storm drain system per HEC-22.

Channel Hydraulic Requirements

Open channels that are part of the initial conveyance system shall be designed to convey the 10-year flow while maintaining one-foot of freeboard. Channels that are located within a FEMA Special Flood Hazard Area, open channels that are the major conveyance system, and natural drainage channels shall be designed to convey the 100-year flow with one foot of freeboard. All channel sections must be adequately designed, detailed, and constructed, pursuant to the latest edition of HEC 15, to prevent erosion of the channel bed and banks.

Above Ground Storage Basins (Ponds)

Above ground storage basins (ponds) shall be designed as attractive and usable spaces. Water depth should be five feet or less where feasible, appropriate landscaping shall be incorporated, and include elements that eliminate standing water and low flow impacts. Detention ponds shall include a low-flow surface channel, or underdrain that is sized for the 2-year storm event.

The required freeboard for detention basins is two feet in areas where any portion of the pond is constructed above existing ground and one foot when the pond is excavated in existing ground.

Basin side slopes should be 5H:1V or flatter on two or more sides, 4H:1V or flatter slopes on remaining sides, with a minimum 1% bottom slope. If the natural existing slope is greater than 8% then basin side slopes may be increased to 3H:1V. A suitable location for ingress and egress shall be incorporated for ponds deeper than three feet, and this must include an access at least 15-feet wide at less than 15% grade. A minimum five-foot buffer between any pond grading and the property lines shall be provided.

Landscaping: Grass or other suitable landscaping materials should be used, and turf irrigation systems shall be installed for ponds that will be maintained by City personnel, unless a low-maintenance landscaping alternative is approved. Irrigating methods and practices must be accounted for in the hydrologic and infiltration calculations when designing and sizing ponds. Developers will be required to escrow funds to landscape ponds when located on private lots for future reimbursement to the owner who completes the landscaping at a future time. Developers will not use landscaping that may hinder infiltration if it is used in the sizing of the pond or required for Municipal Separate Storm Sewer (MS4) compliance. See infiltration section for more information on infiltration and landscaping requirements.

Easements: If basins are placed on private property, a minimum 20-foot easement for all underground lineal pipeline facilities and access to maintain ponds must be provided. Additionally, an easement must be provided over the pond area and a minimum of five feet beyond the pond top of slope perimeter. The easement shall be ten feet beyond the pond perimeter when an access along the pond edge is required. Pond easements shown on subdivision plats shall have restrictive language labeled with dimensions to facilitate locating in the field.

Basins shall be designed with provisions for an emergency overflow that will avoid flood damage to surrounding properties in the event of a storm exceeding the design capacity of the basin.

Retention basins shall be designed with mechanisms to ensure that the basin will completely drain within 48 hours after the 24-hour event with additional precipitation. (Verify a 72-hour storm will not overtop the basin). See the section on Infiltration in this document for details regarding infiltration requirements.

Basin inlets and outlets shall have trash racks or grates installed. A storm water pretreatment device, approved by the City, shall be installed upstream of the pond or sump inlets. See the Water Quality section of this report for requirements.

Culverts

Culverts that convey off-site flows through a project or beneath a road shall be designed for the 100-year event. Culverts shall be designed so the headwater elevation does not exceed 1.5 times the culvert diameter, or one foot below the elevation where water spills over the road or out of the channel. Concrete box culverts shall have a minimum 5-feet height from floor to ceiling, and multi-barrel culverts may not be used where high amounts of debris is expected. If multi-barrel culverts are used in other locations, designers must consider elevations of roads, buildings, driveways, and other features to prevent adverse impacts. Normal depth equations (Manning's Equations) cannot be used for culvert analysis. Inlet and outlet control shall be checked, and culvert hydraulic calculations provided.

Roadway Drainage

Inlets within roadways should be placed to control spread, or the amount of water flowing along the side of the road and in the gutter. Allowable spread is determined by the roadway classification as follows:

Table 1. Design Spread for Roadways

Design Frequency and Spread		
Roadway Classification	**Design Frequency**	**Design Spread**
Highway or Major Collector > 35 MPH	10-Year @ T_c	Shoulder (Outside of travel lane)
Highway or Major Collector ≤ 35 MPH	10-Year @ T_c	Shoulder + three feet
Local Street	10-Year @ T_c	½ Driving Lane

Inlets should also be placed upstream of intersections and pedestrian ramps to reduce bypass flows. Spread calculations shall be checked using HEC 22, Appendix A, Chart 1B.

Rainfall Runoff Computation Methods

Precipitation data obtained from the NOAA ATLAS 14 Point Precipitation Frequency website including intensity and depth data for Heber City is contained in Appendix B. This information shall be used for all development within Heber City.

Several hydrologic methods may be applicable depending on what type of analysis is required. The Rational Method is the most common method and may be used for sizing pipes, checking inlet spread and estimating peak flow rates for areas up to 100 acres.

Rational Method runoff coefficients are shown in Table 2. The runoff coefficients listed in Table 2 are the minimum values to be used in Heber City. Any runoff coefficients for other characteristics should be adjusted to account for the 100-year rainfall.

Table 2. Rational Runoff Coefficients

Surface or Cover Type *	**Runoff Coefficient (C)**
Asphalt or Concrete Pavement	0.90 (asphalt) 0.95 (concrete)
Roofs of Buildings (type dependent)	0.90 (asphalt shingles) 0.95 (steel)
Grass-covered Sandy Soils, Slopes 2% or less	0.13
Grass-covered Sandy Soils, Slopes > 2%	0.20
Grass-covered Clay Soils, Slopes 2% or less	0.22
Grass-covered Clay Soils, Slopes > 2%	0.49

* Surfaces not addressed in this table shall be approved by the City Engineer.

For storm analyses that require developing a volume or routing a volume of runoff, a hydrograph method should be used. Multiple hydrographs were developed by the Soil Conservation Service (SCS), now known as Natural Resources Conservation Service (NRCS). The SCS Type II 24-hour storm distribution should be used for estimating the precipitation for developments within Heber City.

The SCS method uses the Curve Number Method for determining rainfall runoff. Curve Numbers are determined by using a land cover type in conjunction with a hydrologic soil group. Land cover information can be obtained by means of aerial topography or GIS data. Hydrologic soil group information may be obtained from NRCS's Web Soil Survey website. The land cover and hydrologic soil group information are used to select an appropriate curve number using the manual titled *TR-55 Urban Hydrology for Small Watersheds*. TR-55 worksheets and calculation methods are provided in Appendix G and shall be utilized for developments that use the SCS method to estimate run-off. Typical CN values are included in Appendix C. Engineering judgement should be used when selecting curve numbers. Part

630 of the National Engineering Handbook says, “As a result of construction and other disturbances, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the hydrologic properties of the disturbed soil. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group.” Site specific factors such as terrain, potential precipitation on frozen ground, future conditions and other factors should be considered when selecting curve numbers. The SCS method shall only be used for estimating the run-off for development which are greater than 10 acres.

The Federal Aviation Administration (FAA) Method for estimating detention or retention volumes may also be used for approximating storage facility volume requirements for developments. It is outdated because it does not model the release rate correctly. However, with the Guo Averaging Parameter, it is valid and can be used. However, it is not applicable to in-series (cascading) ponds. This method is applicable for developments less than 100 acres, and the SCS method is required for developments larger than 100 acres. The FAA Method uses a spreadsheet to evaluate several storm durations for a given return period for either the 100-year storm (retention) or 25-year storm (detention). The total inflow volume for a storm duration is developed by multiplying the peak flow rate by the storm duration. The volume out is developed by utilizing a controlled discharge amount (discharge with detention only), and/or exfiltration from the detention pond when conditions permit. The required volume is equal to the inflow volume minus the outflow volume. This is evaluated for all storm durations to determine which storm duration provides the maximum required volume. Developments that use the FAA Method for estimating storage facility volumes shall use the spreadsheets provided by the City including the Guo Averaging Parameter when off-site discharge is utilized. An example is shown in Appendix I, or other approved spreadsheet formats.

Several methods for estimating time of concentration exist. They were each developed for specific parameters such as watershed size, slope, etc. Time of concentration methods used should be applicable to the areas in which they are being analyzed. The minimum time of concentration value should be 5 minutes.

For all software models, input and output data shall be provided so that it can be reviewed by the City. A copy of the model file shall also be provided to the City for review. Models must be provided to the City in Civil 3D Storm and Sanitary Analysis. City may consider other software models based on prior approval from the City Engineer.

Post Construction Peak Discharge

Heber City has adopted a 0.10 cfs/acre maximum release standard for undeveloped areas, i.e., areas outside Central Heber. This rate is assumed to be the historical undeveloped flow. For example, a 10-acre housing development would be able to have a post-development discharge rate of 1.0 cfs (10 acres x 0.10 cfs/acre) provided there is a suitable point to discharge to. If the historic flow is found to be less than the 0.1 cfs/acre, this shall be used as the maximum allowed post-development discharge. Moreover, if the downstream system does not have capacity for the 0.1 cfs/acre discharge rate, the available capacity will become the controlling factor. To ensure that flow from new developments do not exceed 0.10 cfs/acre, detention facilities with controlled discharge are required. In cases where there is no suitable point to discharge to, retention facilities are required. See storage facilities section for more information.

Infiltration

Infiltration of treated storm water into the ground is encouraged. Detention and retention basin volumes may be sized by considering infiltration as an outflow component. Prior to assuming infiltration is a viable option, infiltration tests shall be conducted by a professional geotechnical engineer, geologist, or soil scientist licensed in Utah that determines the infiltration rate and demonstrates that the proposed soil profile is suitable for infiltration and will readily accept the water. Infiltration tests shall be performed using the double ring infiltrometer test in accordance with ASTM D 3385, and shall be performed at the location of where the result will be applied and at the elevation of the bottom of the facility where infiltration will occur. A minimum of two tests shall be performed with a minimum of one test per 10,000 square feet of the infiltration area.

Groundwater elevations shall be determined. Potential ground water level fluctuations shall be considered, and the lowest elevation of any detention basin should be at least two feet higher than the highest seasonal groundwater elevation. All design infiltration rates shall have a safety factor of two (2) or higher applied to the actual rate measured by the official infiltration test.

Only the plan view area at the bottom of the storage facility may be used as an infiltration surface in infiltration calculations unless stage-volume-discharge curves are created and used. Infiltration must not be considered as an outflow prior to the storm water entering the pond, as this could create negative storage volume.

Infiltration rates shall only be applied to the same soil that has been tested. If topsoil or other less permeable soil is added to a storage facility where percolation is being applied, the infiltration rate used in the design shall match rate of the less permeable soil. Alternatively, a permeable layer of gravel shall be used in the entire infiltration area.

An infiltration rate map is included in Appendix D. It is included to provide general infiltration information but shall not replace actual field tests.

Comply with all State groundwater protection regulations, guidelines and permits such as those associated with infiltration, infiltration wells, Class V injection wells and any others applicable to the site.

Long-Term Storm Drain Facility Maintenance

All public storm drain facilities will be maintained by Heber City unless otherwise specified in the development agreements. Developers, property owners, or their representatives such as a Homeowners Association, shall enter into a post-construction storm water management agreement with the City for all privately owned storm drain facilities, and/or publicly owned storm drain facilities that convey storm water from private roads and facilities. See Appendix J for template agreements.

Low Impact Development

Low Impact Development (LID) is a method of reducing storm runoff by capturing, treating, and retaining it on a very local level within each individual development. Although Heber City is not currently on the Utah MS4 list, it is anticipated to become an MS4 community in the future. LID is required by the Utah Department of Environmental Quality as part of an MS4 Program. To prepare for future compliance with the MS4 storm water discharge program and to reduce post-development storm water run-off in general, developments within Heber City must retain and treat the 80th percentile rainfall

event as part of LID requirements. LID measures can also help achieve the onsite retention and treatment requirements. The 80th percentile depth for Heber City has been determined to be 0.47 inches. See Appendix E for this calculation. The Reese method, as shown in Appendix E, shall be used to calculate the volumetric runoff coefficient used for determining the 80th percentile volume. For developments larger than 10 acres use SCS Method to determine 80th percentile volume.

Localized LID methods are encouraged, however, the 80th percentile volume may be incorporated into larger detention or retention storage facilities if those facilities are located on site within the development area, or adjacent to, and if approved by the City Engineer.

Several typical LID measures are described in the following paragraphs. Portions of the LID descriptions have been taken from the Utah City Engineers Association (UCEA) and Utah DEQ LID Manual. See Appendix F for LID general details. The following LID descriptions are the approved LID measures to be used in Heber City. Any other proposed LID measures shall be approved by the City Engineer on a case-by-case basis. Please see the DEQ "Guide to Low Impact Development with Utah" for additional LID design guidelines and design flow-chart requirements.

Vegetated Swales

Vegetated swales may be considered dry or wet swales, and serve as a vegetative buffer between paved areas and storm drain facilities. The main advantages of vegetated swales are the degree of velocity reduction, detention, infiltration, and reduction of hard surface runoff. Storm runoff flows through the swale, where sediment and pollutants may settle out prior to entering downstream drainage facilities. A curb cut is one means of directing flow into swales where changes in elevation are limited.

Swales are often an attractive BMP solution because they can take advantage of already planned park strips. It should be noted that studies have shown that vegetated swales have a moderate ability to remove pollutants from storm water.

Dry Swales

A dry swale is a shallow, gently sloping drainage channel with broad, vegetated, side slopes. Dry swales provide temporary storage, filtration, and infiltration of storm runoff. A dry swale is versatile because it requires a relatively small area. Reduced channel velocities increase infiltration and water quality treatment and may reduce peak runoff. Channel vegetation can include turf, meadow grass, shrubs, and in limited quantities, small trees. Dry swales must be located above the water table to provide drainage. Dry swales are only allowed when groundwater is equal to or greater than 2-feet below the swale bottom elevation. When infiltrations rates are greater than 6.0 in/hour, dry swales shall either be designed as a biofilter for treatment of storm water or be preceded by an approved pre-treatment system. See the Water Quality section in this report for requirements. Retention LIDs shall provide treatment through settling, decreased flow rate, and bioretention with a designed release time.

Wet Swales

Wet swales are a type of filtration BMP and occur when the water table is located close to the surface. Wet swales act as a long and linear shallow treatment system. Like dry swales, check dams can be used as needed to create cells and contain the entire water quality treatment volume. Cells may be planted with emergent wetland plant species to improve pollutant removal. Wet swales, at a minimum, shall be preceded by a pre-treatment device to capture and remove pollutants and coarse sediment particles, see the Water Quality section below.

Infiltration Basin/Galleries

An infiltration basin is essentially a detention basin that is constructed such that storm water can exit the basin by means of infiltration into the surrounding ground. These include underground pipe and chamber systems. These systems can reduce pollutants by settling out or filtering materials and any pollutants that may be bound to those materials. They are also effective at reducing nutrients, metals and other pollutants.

Basins with no outlet or highly restricted outlets can be effective at eliminating pollutants, but there is some risk of concentrating pollutants or introduction of pollutants to groundwater that must be considered. One way to address this is by the utilization of a biofilter, hydrodynamic separator (HDS), or other pollutant removal measures within or upstream of a basin that is sized to handle the water quality design storm. All infiltration basins shall be preceded by a pre-treatment or treatment system to capture and remove pollutants and coarse sediment particles, see requirements in the Water Quality section below.

Basins and galleries must be sized to drain within 48 hours after the end of the design storm and to not overtop in the 72-hour storm.

Underground injection wells are included in this category, but water quality and applicable regulations must be considered and utilized.

Rain Gardens

A rain garden is a planted depression or similar feature that allows storm runoff from impervious urban areas like roofs, driveways, walkways, parking lots, and compacted lawn areas the opportunity to infiltrate into the soil.

Rain gardens are an LID tool that can be used in new or established developments. Rain gardens can be constructed in commercial and residential sites. The garden may be located near a street or parking lot in a shallow depression where runoff can be diverted into it. Native perennial plants are recommended in rain gardens with a barrier to reduce weeds. Nutrients in the storm runoff are reduced as plants or other growing media make use of them to grow.

Rain gardens can be constructed to allow infiltration. Where complete infiltration is not desired or is not feasible due to existing soil conditions, an underdrain may be installed to convey excess water to a storm drain retention system.

Studies underway at Utah State University have identified common reed and sedges are the optimal plant for use in northern Utah to remove nutrients, metals, and other pollutants (Dupont and McLean), but it must be harvested and disposed of elsewhere at regular intervals to prevent concentration of pollutants in the soil or in the biofilters. Mulching and leaving in place does not address this. Whether such concentrations are critical depends on the contact with groundwater, and is still under study.

Root zone soil media must be shallow and water must pool or move slowly through the system or the pollutant removal is ineffective.

Rain garden filtration media shall meet the specification for biofilters (see Water Quality section below), are only allowed in private areas, and shall be maintained by the property owner.

Water Quality

Water quality is of utmost importance to Heber City. There are a variety of mechanisms to protect water quality from storm drain discharge systems. All storm water must pass through a pre-treatment or treatment system prior to discharging to a storage facility (above or below ground) that captures the 25-year to 100-year storm events. LID measures are intended to reduce storm runoff and to improve overall water quality. However, as most LID measures rely on infiltration, water quality must also be considered during design and implementation. Unless the native soil infiltration rate is less than 6.0 in/hr and/or the LID facility is designed and determined to treat the storm water (biofilter treatment), an approved hydrodynamic separator (HDS) pre-treatment device shall be used prior discharging to LID systems. All storm water that flows over an impervious surface must be treated.

Pre-treatment and Treatment Systems

Pre-treatment and treatment systems shall be sized, at a minimum, to treat the 2-year storm event at the duration that produces the highest flow rate while also being able to by-pass the peak conveyance storm at the time of concentration (T_c) without disrupting the treatment system. The peak conveyance storm represents the actual capacity of the initial conveyance system and may be larger than the 10-year event. Note, treatment systems that also serve as LID retention areas may be sized for the 80th percentile storm event but shall adhere to the by-pass requirements stated above. Requirements for pre-treatment and treatment are listed below.

Oil-Water and Hydrodynamic Separators (HDS) Pre-Treatment Devices:

All developments are required to install an appropriately sized hydrodynamic separator (HDS) prior to discharging to the retention/detention storage facility that captures the 25-year to 100-year storm events unless the LID methods utilized in the development incorporate a sized biofilter per the specification listed below and the storm water is not re-introduced to a source of pollution after it flows through the localized LID methods. Pre-treatment devices shall be maintained at least twice per year and per the guidelines provided by the manufacturer. All HDS devices must achieve, at a minimum, the following treatment levels:

- The HDS system shall be required to have a General Use Level Designation (GULD) performance verification through the TAPE program (Emerging stormwater treatment technologies (TAPE) - Washington State Department of Ecology). The device shall be sized to treat the peak runoff flow rate generated by the 2-year storm event at the Tc, when using Rational Method. Use the storm duration and distribution that creates the highest flow rate during a 2-year storm event when using other run-off computation methods.The proposed hydraulic loading rate (HLR) must not exceed the design HLR of the proposed device to be used. TAPE approval letters can be found on the website and provide the design HLR and/or the maximum treatment flow rate for each model.
- The HDS system shall be concrete unless otherwise approved by the City Engineer
- The HDS system shall provide 90% removal of trash and neutrally buoyant material larger than 5mm at the design treatment flow rate. Adding a screen to the tested system is not allowed to meet this spec, as modifying a TAPE verified system with a screen can significantly affect hydraulics, and thus water quality performance.

- The HDS system shall be designed to by-pass the peak conveyance storm event and prevent these larger storm events from washing out the oil, debris, and sediment that has been previously captured (off-line storage).
- The HDS system shall provide a minimum sump and oil storage capacity as follows:

Treatment Capacity Range (cfs)	Minimum Sump Storage Capacity (yd^3)	Minimum Oil Capacity (gal)
0-4	> 0.4	> 60
4-9	> 2	> 200
9-20	> 4	> 500
> 20	> 8	> 1000

Biofilter Treatment Systems: Biofilter is a generic description for bioswales, vegetated filter strips, rain gardens, or other structures that use a filtration media to capture storm water pollutants. The pollutants are decomposed by a biomass such as plants, a tree, or a specially designed biofilter media. These systems are typically connected to a storm drain system and if used shall be combined with detention/retention facilities.

All biofilters shall be sized to treat the 2-year T_c storm event flow rate while also be sized to by-pass larger flows without disrupting the treatment system. Biofilters shall treat the storm water prior to infiltrating into the native soils with infiltration rates greater than 6.0 in/hr and/or prior to discharging to a detention/retention facility unless a sized HDS system is properly incorporated as pre-treatment.

The growing media of the biofilter and shall be designed and certified to meet the following specifications.

RAIN GARDEN GROWING MEDIA (Soil + Organics)

Assume a saturated hydraulic conductivity rate of 2.0 in/hr. Then, divide it by a safety factor of 2.0. So, the net rate is 1.0 in/hr.

RAIN GARDEN SOIL

Particle Size Distribution

sand: 70-80%

silt: 0-30%

clay: 0-15%

Chemical Attribute and Nutrient Analysis

pH: 6.8-7.5

organic matter: < 1.5%

nitrogen: < 15 ppm

phosphorous: < 15 ppm

salinity: < 6 mmhos/cm

RAIN GARDEN ORGANICS

shredded mulch: 3-5% (by weight of growing media)

VEGETATION

The filter area shall be vegetated with drought tolerant species that thrive in sandy soils. Table 3 provides a suggested seed mix for sites that will not need to be irrigated after the grass has been established.

Table 3. Suggested Seed Mix

Common Name	Scientific Name	Variety	PLS[2] lbs per Acre	Ounces per Acre
Sand bluestem	Andropogon hallii	Garden	3.5	
Sideoats grama	Bouteloua curtipendula	Butte	3	
Prairie sandreed	Calamovilfa longifolia	Goshen	3	
Indian ricegrass	Oryzopsis hymenoides	Paloma	3	
Switchgrass	Panicum virgatum	Blackwell	4	
Western wheatgrass	Pascopyrum smithii	Ariba	3	
Little bluestem	Schizachyrium scoparium	Patura	3	
Alkali sacaton	Sporobolus airoides		3	
Sand dropseed	Sporobolus cryptandrus		3	
Pasture sage[1]	Artemisia frigida			2
Blue aster[1]	Aster laevis			4
Blanket flower[1]	Gaillardia aristata			8
Prairie coneflower[1]	Ratibida columnifera			4
Purple prairieclover[1]	Dalea (Petalostemum) purpurea			4
Sub-Totals:			27.5	22
Total lbs per acre:			**28.9**	

[1] Wildflower seed (optional) for a more diverse and natural look.
[2] PLS = Pure Live Seed.

EXECUTION

thickness: >/= 18 inches

compaction: 80-85% of maximum dry density as measured by AASHTO T-99 (ASTM D698)

vegetation: Mix seed well and broadcast, followed by hand raking to cover seed and then mulched. Hydromulching can be effective for large areas. Do not place seed when standing water or snow is present or if the ground is frozen. Weed control is critical in the first two to three years, especially when starting with seed. When using sod, specify sand–grown sod. Do

not use conventional sod. Conventional sod is grown in clay soil that will seal the filter area, greatly reducing overall function of the BMP.

Irrigation: Provide spray irrigation at or above the WQCV elevation or place temporary irrigation on top of the rain garden surface. Do not place sprinkler heads on the flat surface. Remove temporary irrigation when vegetation is established. If left in place this will become buried over time and will be damaged during maintenance operations. Adjust irrigation schedules during the growing season to provide the minimum water necessary to maintain plant health and to maintain the available pore space for infiltration.

Water Quality Control Measures

Other water quality control requirements are listed below.

Detention/Retention Facilities (Pollutant Control, LID): Detention basins are used to attenuate peak flow rates of a runoff hydrograph. They also can be designed to allow sediment, debris, and other contaminants to settle out by reducing water velocity or holding the water until it infiltrates or evaporates.

Retention facilities have no outlet and water is removed by infiltration or evaporation. Retention basins still function as a BMP the same way a detention basin does. Detention and retention facilities shall be used in combination with hydrodynamic separators or biofiltration systems.

These facilities require regular maintenance to remove debris, contaminants, and sediment build-up.

Outlet Protection/Energy Dissipation Devices: Outlet protection reduces or eliminates soil erosion thereby preventing the migration of soil to downstream channels. Outlet protection, pursuant to HEC 14, is required at all open discharge points.

Slope Protection: Slope protection ensures slopes will be stable during and after construction. The primary means of stabilization of a slope is establishing permanent vegetation, but may also consist of temporary or permanent rock, mulch, erosion control blankets, check dams, diversion dikes, or other means of protection. All slopes shall be stabilized after disturbance. Slopes of 3H:1V and steeper require permanent slope stabilization.

Source Protection

The Utah Division of Drinking Water requires that each well and spring serving a public drinking water system must have a source protection plan. Part of that plan includes the protection of groundwater from point and non-point sources. Developers within Heber must certify that all private and public source protection zones are protected from storm water pollutants. Source protection zones for Heber City culinary water sources are shown on the source protection maps in Appendix H.

Storm water infiltration, drainage wells, or storm water injection wells are prohibited within 100 feet of Zone 1 of any source protection area. All storm drain storage facilities within 100 feet of a Zone 1 area shall be lined with an approved waterproof liner to prevent all storm water infiltration.

Natural Channels

Natural or manmade drainage channels shall remain undeveloped with a total width minimum 100-feet undeveloped buffer split between both sides of the channel. The entire drainage channel shall be protected and remain undisturbed with the exception of road or other crossings. Road crossings of the natural channels shall be minimized with a minimum distance, measured along the channel, between crossings of 250-feet. Relocation of drainage channels shall be approved by governing entities and Heber City.

Flood and Debris Flow Hazards

FEMA Flood Analysis

Ensure all pertinent FEMA flood mapping data is incorporated into plans and plats maps. Ensure all FEMA guidelines from https://www.fema.gov are followed including the sections on Floods & Maps, Floodplain Management, and Flood Insurance. FEMA uses the most accurate flood hazard information available and applies rigorous standards in developing Flood Insurance Rate Maps (FIRMs). All areas within Flood Hazard Areas shall be shown on plans and plats, and all Base Flood Elevation (BFE) data pertinent to the development must be provided.

To change the FIRM designation of a property, a Letter of Map Amendment (LOMA) and/or the Letter of Map Revision-Based on Fill (LOMR-F) processes must be strictly followed.

Debris-Flow Flood Hazard Analysis

The Western Unities states is beginning to see increased precipitation intensity and increasing fire size and frequency (Kean and Staley et al, 2021). Generally, there is not adequate time to prevent or mitigate a debris flow hazard *after* a wildfire has taken place. The USGS has found that 1-year storm events will typically trigger a post-wildfire debris flow event. Therefore, if a wildfire takes place, some type of debris flow is likely to happen within 1-year of the fire. These types of hazards should be prevented or controlled as deemed feasible. New development with undeveloped land upstream or downstream of the property containing natural slopes 30% and greater and/or where the City Engineer determines there could be a potential debris-flow risk, requires a specialized post wild-fire debris-flow analysis of the site including an estimated post-fire hazard assessment with mitigation measures.

Flood and Debris-flow hazard analysis reports shall include but shall not be limited to the following information for the areas to be developed:

- FEMA Flood Mapping Data including 100-year flood hazard zones
- Include and label the drainageways susceptible to periodic flooding associated with storm events or rapid snowmelt that are outside the FEMA designated flood zones
- U.S. Geological Survey Map
- Aerial Map
- Contour map with slopes labeled
- Geotechnical Test pit data
- Geologic Mapping Data to include historic upstream and downstream alluvial fan deposits and historic upstream or pass-through debris/mud flows as data is available.
- Vegetative cover type and percentage analysis

- Utah Division of Water Rights – Dam Safety requirements
- Post-fire debris-flow volume calculations with flood and post-fire debris-flow hazard assessment and mitigation

Flood and post-fire debris-flow hazard assessment and mitigation recommendations shall adhere to the following guidelines:

At a minimum, the volume of debris sediment shall be calculated using the model equation (2) from the 2010 Cannon study (Cannon et al,, 2010). The entire drainage basin shall be modeled. Methods from the Gartner 2014 study and equation (3) may also be used until another model paper is published and adopted by USGS. (Gartner et al., 2014).

The minimum storm event interval shall be a 10-year occurrence with a T_c peak rainfall depth, unless otherwise approved by the City Engineer. Intensity is used for the Gartner method.

When the Gartner method is used, the watershed area burned at moderate to high severity shall be calculated based on a vegetation type assessment of the entire drainage basin. Vegetation type and coverage area data shall be obtained and summarized under the direction of a licensed Professional Engineer or other approved licensed professional. Forested areas and other areas with small or large tree species (deciduous or evergreen) and/or thick brush, such as Gambel Oak shall be assumed to burn at moderate to high severity. Staley et al. (2018) spells out further guidance on vegetation types and burn severity per vegetation type.

Debris flow is difficult to accurately model due to the nature of the material being carried by the storm water, especially if the natural channel that the debris flow will enter and travel through is altered by road crossings, culverts, or other diversions/obstructions over and through the natural channel. Unless the natural channel is undisturbed and can be accurately modeled to safely convey the debris flow without having to travel through any obstructions, culverts, roads, etc. that would otherwise plug or divert the flow off-course, the estimated debris volume needs to be contained in a debris-basin upstream from development. Road or other crossings shall be designed to allow and divert debris flow and/or flood water over the crossing using depression or other mechanism to allow the flow to pass the crossing continue down the natural channel. Other measures to contain and/or divert the debris volume may be considered, as approved by the City Engineer.

References

Cannon, S.H., Gartner, J.E., Rupert, M.G., Michael, J.A., Rea, A.H., & Parrett, C. (2010). Predicting the probability and volume of postwildfire debris flows in the intermountain western United States. *GSA Bulletin*, *v. 122*(1-2), 127-144. https://doi.org/10.1130/B26459.1

Gartner, J.E., Cannon, S.H., & Santi, P.M. (2014). Empirical models for predicting volumes of sediment deposited by debris flows and sediment-laden floods in the transverse ranges of southern California. *Engineering Geology*, *176*, 45-56. https://doi.org/10.1016/j.enggeo.2014.04.008

Kean, J.W., & Staley, D.M. (2021). Forecasting the frequency and magnitude of postfire debris flows across southern California. *Earth's Future*, *9*(3), e2020EF001735. https://doi.org/10.1029/2020EF001735

Staley, D.M., Tillery, A.C., Kean, J.W., McGuire, L.A., Pauling, H.E., Rengers, F.K., & Smith, J.B. (2018). Estimating post-fire debris-flow hazards prior to wildfire using a statistical analysis of historical distributions of fire severity from remote sensing data. *International Journal of Wildland Fire*, *27*(9), 595-608. https://doi.org/10.1071/WF17122

Appendices

Appendix A

Drainage Design Resources

Standard Drawings | Heber City, UT (heberut.gov)

Standard Specifications | Heber City, UT (heberut.gov)

Storm-Intensity-Curves-PDF (heberut.gov)

Low Impact Development - Utah Department of Environmental Quality

DWQ-2019-000161.pdf (utah.gov)

Microsoft PowerPoint - A Guide to Low Impact Development within Utah (Training)

Emerging stormwater treatment technologies (TAPE) - Washington State Department of Ecology

Nonpoint Source: Urban Areas | US EPA

DRAFT

Appendix B

(IDF Data)

Precipitation Frequency Estimates (in/hr)										
Average recurrence interval (years)	5-min	10-min	15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
1	1.54	1.16	0.96	0.646	0.4	0.251	0.191	0.126	0.079	0.047
2	1.94	1.48	1.22	0.824	0.51	0.314	0.237	0.155	0.097	0.058
5	2.68	2.03	1.68	1.13	0.699	0.413	0.302	0.191	0.118	0.072
10	3.34	2.54	2.1	1.41	0.873	0.505	0.364	0.223	0.137	0.083
25	4.38	3.34	2.76	1.86	1.15	0.656	0.46	0.27	0.163	0.099
50	5.38	4.09	3.38	2.27	1.41	0.794	0.545	0.31	0.185	0.112
100	6.52	4.96	4.1	2.76	1.71	0.958	0.647	0.355	0.209	0.125
200	7.86	5.98	4.94	3.33	2.06	1.15	0.772	0.405	0.234	0.14
500	10	7.63	6.31	4.25	2.63	1.46	0.985	0.499	0.273	0.159
1000	12	9.13	7.55	5.08	3.14	1.75	1.18	0.597	0.307	0.175

Precipitation Frequency Estimates (inches)										
Average recurrence interval (years)	5-min	10-min	15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
1	0.13	0.19	0.24	0.32	0.40	0.50	0.57	0.75	0.95	1.13
2	0.16	0.25	0.31	0.41	0.51	0.63	0.71	0.93	1.17	1.40
5	0.22	0.34	0.42	0.57	0.70	0.83	0.91	1.14	1.43	1.72
10	0.28	0.42	0.52	0.71	0.87	1.01	1.09	1.34	1.65	2.00
25	0.37	0.56	0.69	0.93	1.15	1.31	1.38	1.62	1.97	2.38
50	0.45	0.68	0.84	1.14	1.41	1.59	1.64	1.86	2.23	2.69
100	0.54	0.83	1.03	1.38	1.71	1.92	1.94	2.12	2.51	3.01
200	0.66	1.00	1.24	1.66	2.06	2.30	2.32	2.43	2.82	3.35
500	0.84	1.27	1.58	2.12	2.63	2.93	2.96	2.99	3.29	3.82
1000	1.00	1.52	1.89	2.54	3.14	3.50	3.54	3.57	3.70	4.20

NOAA Atlas 14, Volume 1, Version 5 (Feb 2022)
Location name: Heber City, Utah, USA
Latitude: 40.4924°, Longitude: -111.4129°
Elevation: 5642.1 ft
Refer to NOAA Atlas 14 document for more information

NOAA Atlas 14, Volume 1, Version 5
Location name: Heber City, Utah, USA*
Latitude: 40.4924°, Longitude: -111.4129°
Elevation: 5642.1 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.128** (0.111-0.149)	**0.162** (0.142-0.190)	**0.223** (0.194-0.261)	**0.278** (0.239-0.326)	**0.365** (0.306-0.433)	**0.448** (0.364-0.533)	**0.543** (0.428-0.653)	**0.655** (0.496-0.799)	**0.836** (0.601-1.04)	**1.00** (0.689-1.27)
10-min	**0.194** (0.169-0.227)	**0.247** (0.215-0.289)	**0.338** (0.294-0.397)	**0.423** (0.363-0.497)	**0.556** (0.465-0.659)	**0.681** (0.553-0.811)	**0.827** (0.651-0.994)	**0.997** (0.755-1.22)	**1.27** (0.914-1.59)	**1.52** (1.05-1.94)
15-min	**0.240** (0.210-0.282)	**0.306** (0.267-0.359)	**0.420** (0.365-0.493)	**0.524** (0.450-0.615)	**0.690** (0.576-0.816)	**0.844** (0.686-1.00)	**1.02** (0.807-1.23)	**1.24** (0.936-1.51)	**1.58** (1.13-1.97)	**1.89** (1.30-2.40)
30-min	**0.323** (0.282-0.380)	**0.412** (0.359-0.483)	**0.565** (0.491-0.663)	**0.706** (0.606-0.829)	**0.929** (0.776-1.10)	**1.14** (0.924-1.35)	**1.38** (1.09-1.66)	**1.66** (1.26-2.03)	**2.12** (1.53-2.65)	**2.54** (1.75-3.24)
60-min	**0.400** (0.349-0.470)	**0.510** (0.445-0.598)	**0.699** (0.608-0.821)	**0.873** (0.750-1.03)	**1.15** (0.960-1.36)	**1.41** (1.14-1.68)	**1.71** (1.34-2.05)	**2.06** (1.56-2.51)	**2.63** (1.89-3.28)	**3.14** (2.16-4.01)
2-hr	**0.502** (0.447-0.578)	**0.627** (0.559-0.719)	**0.826** (0.732-0.950)	**1.01** (0.885-1.16)	**1.31** (1.12-1.52)	**1.59** (1.32-1.85)	**1.92** (1.54-2.27)	**2.30** (1.78-2.77)	**2.93** (2.15-3.62)	**3.50** (2.46-4.43)
3-hr	**0.573** (0.515-0.649)	**0.712** (0.640-0.804)	**0.908** (0.810-1.03)	**1.09** (0.967-1.24)	**1.38** (1.20-1.57)	**1.64** (1.39-1.88)	**1.94** (1.60-2.28)	**2.32** (1.84-2.80)	**2.96** (2.22-3.65)	**3.54** (2.54-4.47)
6-hr	**0.754** (0.690-0.838)	**0.929** (0.847-1.03)	**1.14** (1.04-1.28)	**1.34** (1.21-1.49)	**1.62** (1.44-1.81)	**1.86** (1.62-2.09)	**2.12** (1.82-2.42)	**2.43** (2.03-2.81)	**2.99** (2.42-3.69)	**3.57** (2.76-4.51)
12-hr	**0.954** (0.875-1.05)	**1.17** (1.07-1.30)	**1.43** (1.30-1.58)	**1.65** (1.50-1.82)	**1.97** (1.76-2.19)	**2.23** (1.97-2.50)	**2.51** (2.18-2.85)	**2.82** (2.40-3.24)	**3.29** (2.71-3.86)	**3.70** (2.98-4.56)
24-hr	**1.13** (1.06-1.21)	**1.40** (1.31-1.50)	**1.72** (1.62-1.85)	**2.00** (1.87-2.13)	**2.38** (2.21-2.54)	**2.69** (2.48-2.87)	**3.01** (2.77-3.21)	**3.35** (3.06-3.58)	**3.82** (3.45-4.10)	**4.20** (3.76-4.61)
2-day	**1.30** (1.22-1.40)	**1.62** (1.51-1.74)	**1.98** (1.85-2.12)	**2.28** (2.13-2.44)	**2.71** (2.52-2.90)	**3.04** (2.81-3.25)	**3.39** (3.11-3.62)	**3.75** (3.42-4.02)	**4.24** (3.83-4.56)	**4.63** (4.14-5.00)
3-day	**1.44** (1.35-1.54)	**1.78** (1.67-1.92)	**2.18** (2.05-2.34)	**2.52** (2.35-2.69)	**2.97** (2.77-3.18)	**3.34** (3.09-3.57)	**3.71** (3.42-3.97)	**4.09** (3.75-4.39)	**4.62** (4.19-4.97)	**5.03** (4.52-5.44)
4-day	**1.57** (1.48-1.69)	**1.95** (1.83-2.09)	**2.39** (2.24-2.56)	**2.75** (2.57-2.94)	**3.24** (3.03-3.47)	**3.63** (3.37-3.89)	**4.03** (3.73-4.32)	**4.44** (4.08-4.77)	**5.00** (4.55-5.39)	**5.44** (4.90-5.88)
7-day	**1.87** (1.74-2.02)	**2.30** (2.15-2.49)	**2.81** (2.62-3.04)	**3.23** (3.00-3.49)	**3.80** (3.53-4.11)	**4.25** (3.92-4.59)	**4.71** (4.33-5.10)	**5.18** (4.73-5.61)	**5.82** (5.26-6.34)	**6.31** (5.67-6.90)
10-day	**2.14** (1.98-2.31)	**2.64** (2.46-2.85)	**3.21** (2.99-3.47)	**3.67** (3.40-3.96)	**4.29** (3.97-4.63)	**4.75** (4.39-5.14)	**5.23** (4.80-5.65)	**5.70** (5.22-6.18)	**6.34** (5.75-6.88)	**6.81** (6.14-7.44)
20-day	**2.81** (2.63-3.02)	**3.47** (3.25-3.74)	**4.20** (3.93-4.51)	**4.76** (4.45-5.11)	**5.50** (5.13-5.91)	**6.05** (5.63-6.50)	**6.60** (6.11-7.10)	**7.13** (6.58-7.69)	**7.81** (7.16-8.44)	**8.31** (7.60-9.02)
30-day	**3.40** (3.19-3.62)	**4.20** (3.95-4.47)	**5.03** (4.73-5.35)	**5.66** (5.32-6.02)	**6.49** (6.09-6.89)	**7.08** (6.64-7.54)	**7.67** (7.17-8.18)	**8.23** (7.68-8.78)	**8.94** (8.28-9.56)	**9.45** (8.72-10.1)
45-day	**4.28** (4.02-4.57)	**5.28** (4.96-5.64)	**6.31** (5.93-6.72)	**7.09** (6.65-7.55)	**8.08** (7.56-8.60)	**8.79** (8.20-9.35)	**9.47** (8.81-10.1)	**10.1** (9.38-10.8)	**10.9** (10.1-11.6)	**11.4** (10.5-12.3)
60-day	**5.09** (4.79-5.42)	**6.28** (5.91-6.70)	**7.45** (7.02-7.93)	**8.32** (7.83-8.84)	**9.39** (8.82-9.97)	**10.1** (9.50-10.8)	**10.8** (10.2-11.5)	**11.5** (10.7-12.2)	**12.3** (11.4-13.1)	**12.8** (11.9-13.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

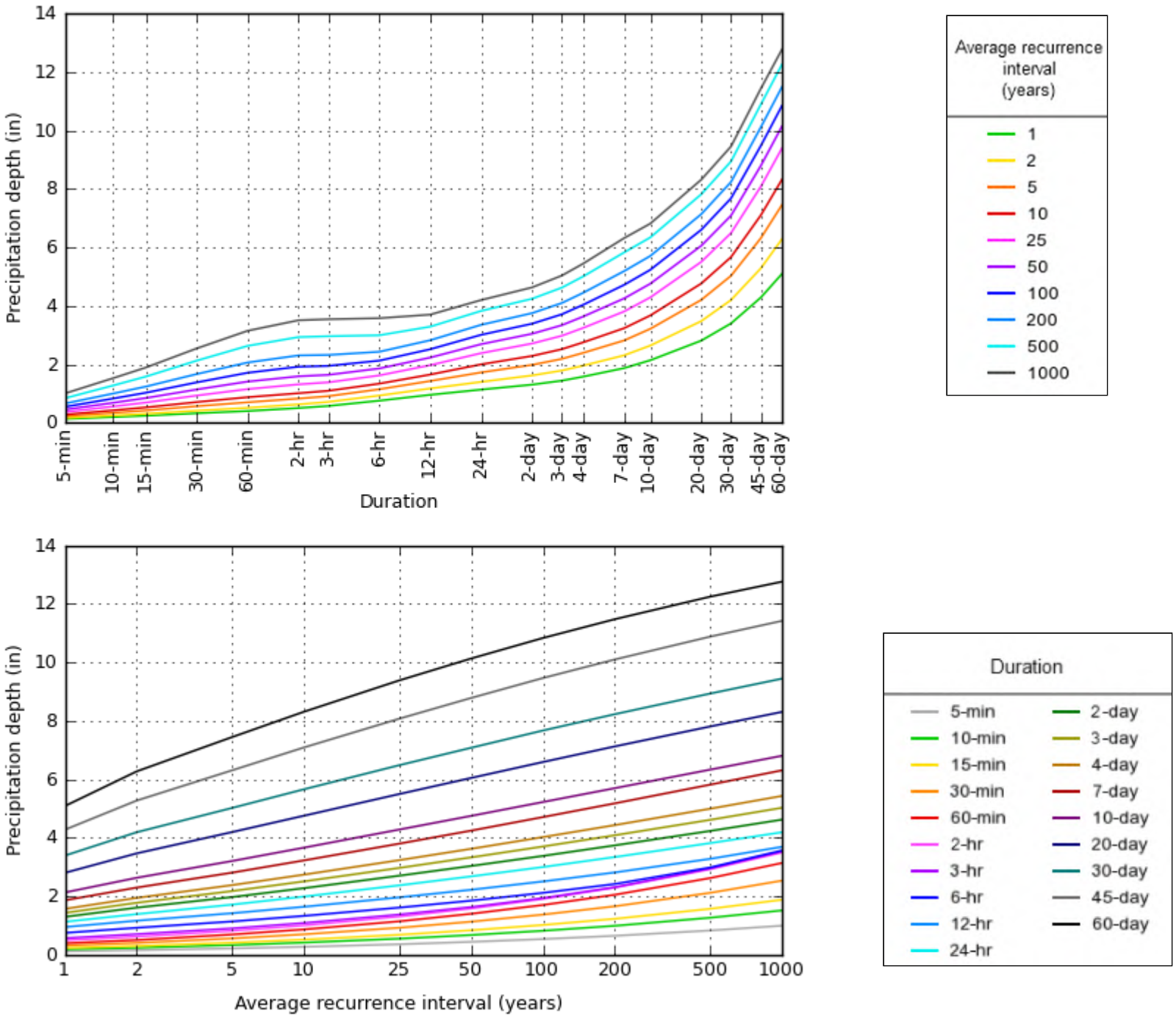
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.4924°, Longitude: -111.4129°

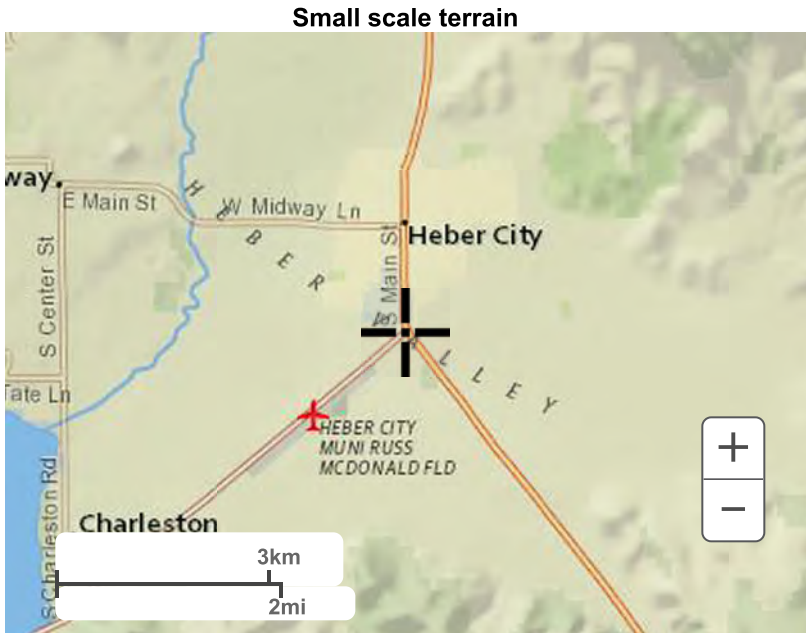


NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Thu Feb 10 17:47:32 2022

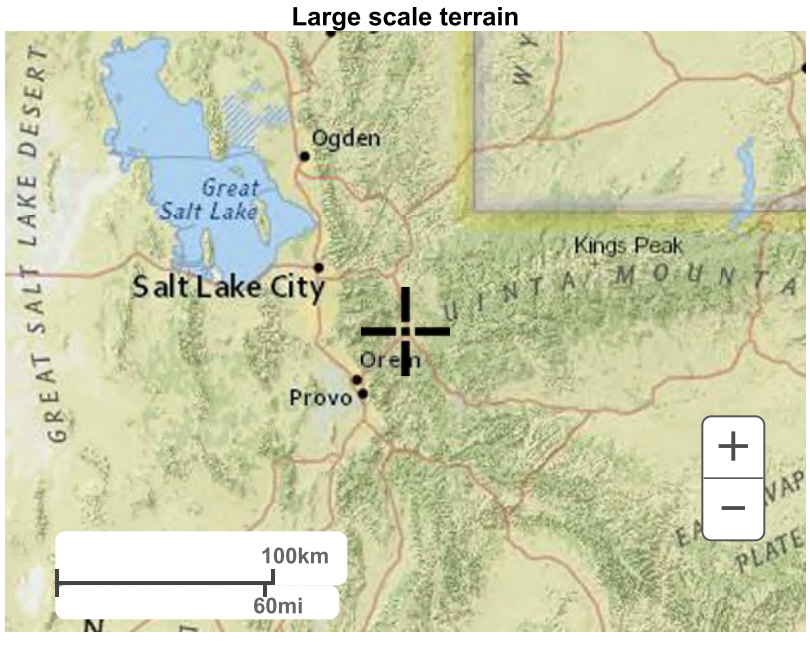
Back to Top

Maps & aerials

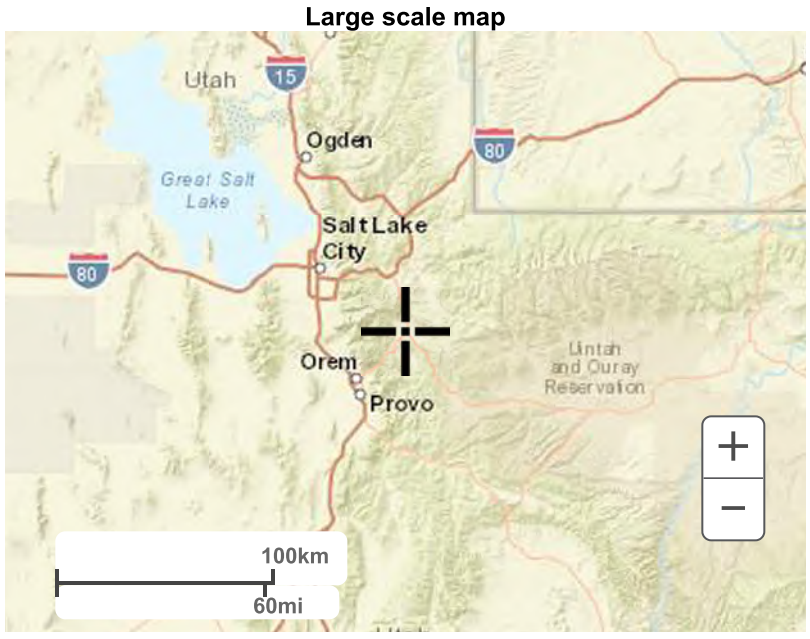
Small scale terrain



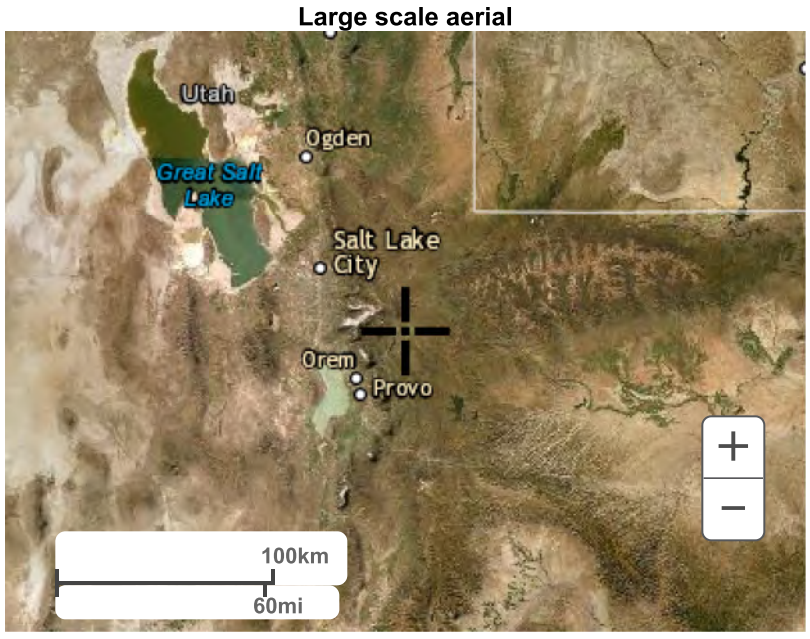
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix C

(CN Tables)

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

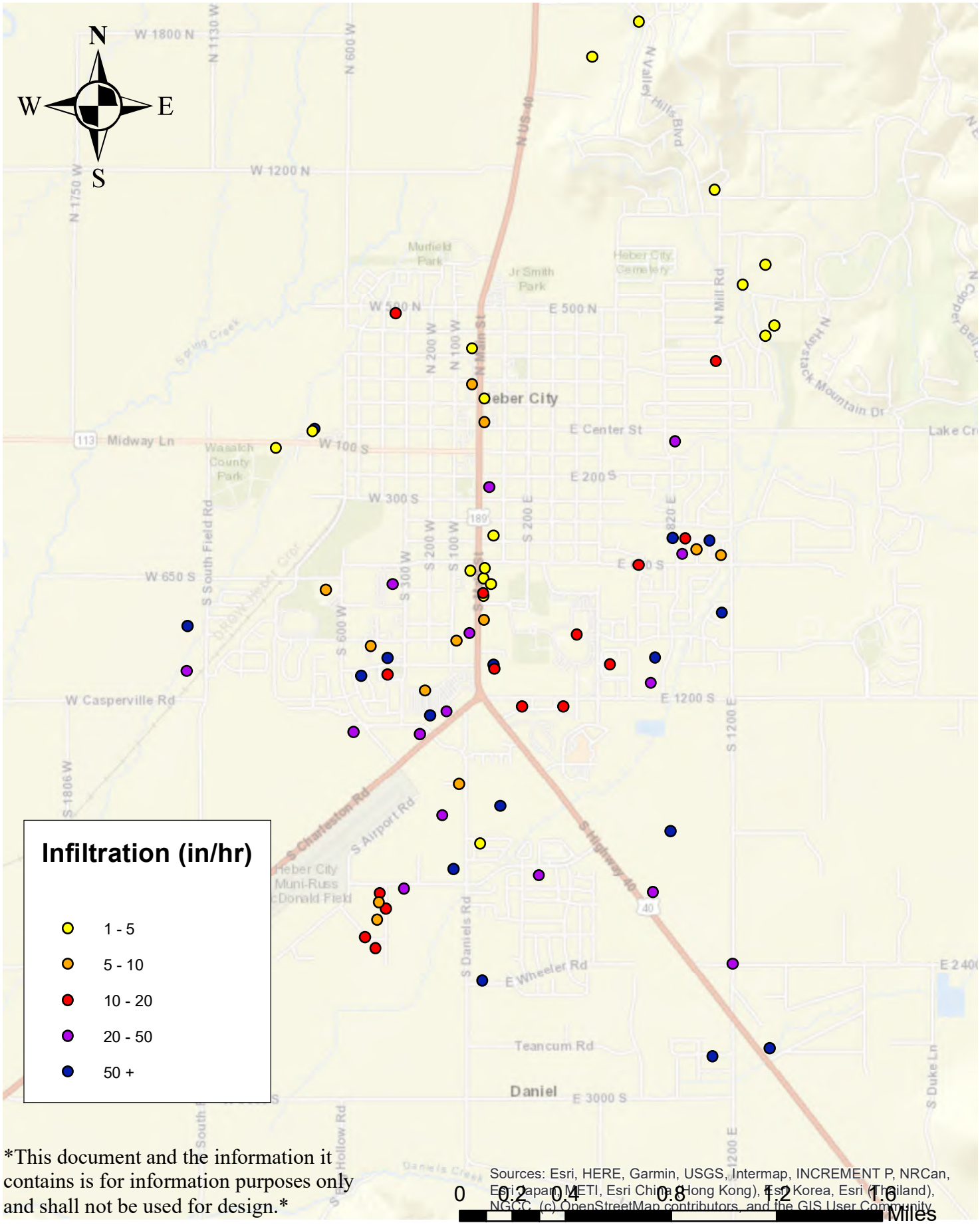
Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Appendix D

(Infiltration & Groundwater Maps)



This document and the information it contains is for information purposes only and shall not be used for design.

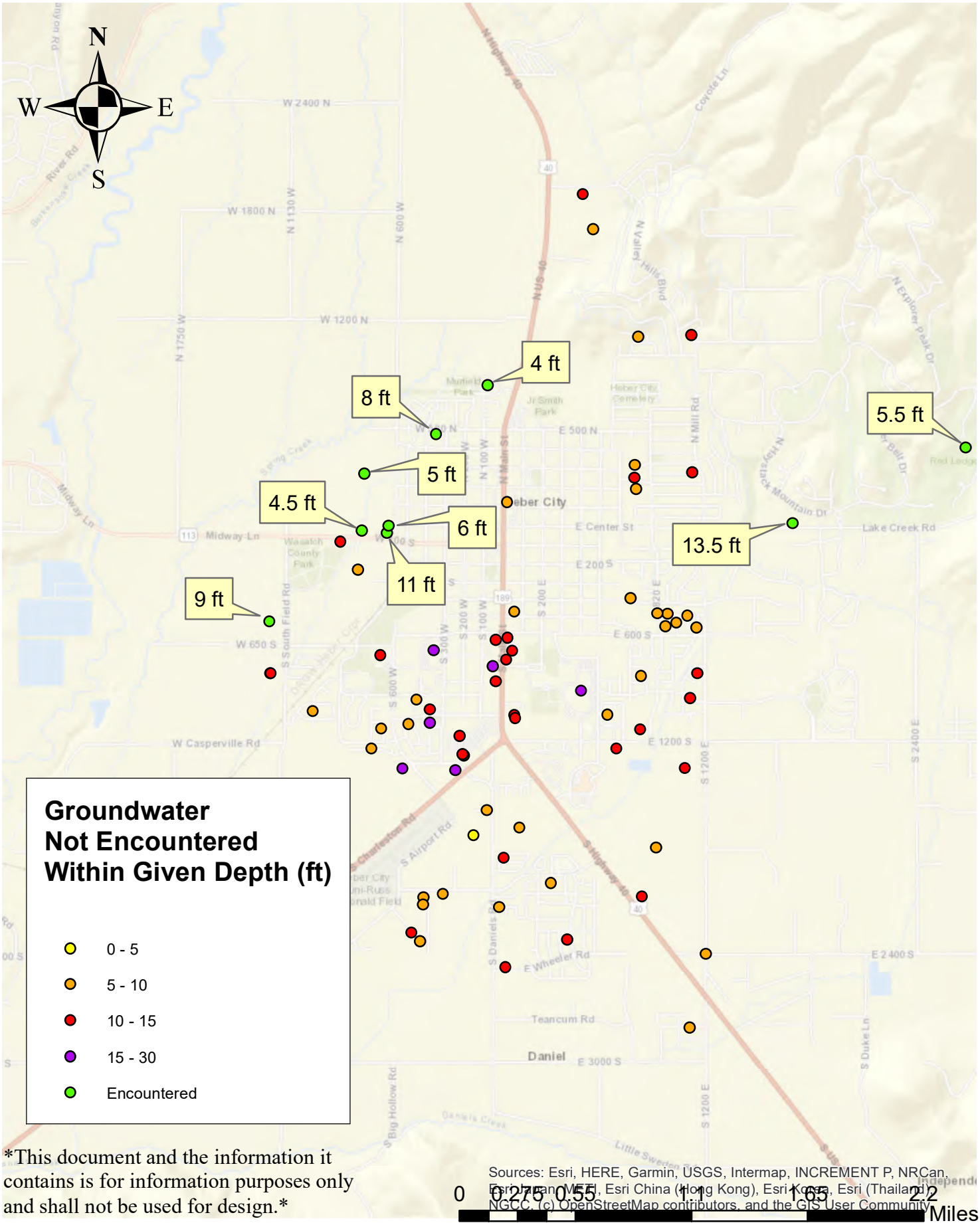
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

C:\Users\alecvandegraaff\Desktop\Heber Master Plan\Infiltration_BACKUP.mxd, 6/9/2022 10:23:31 AM, alecvandegraaff

HORROCKS ENGINEERS
728 West 100 South
Heber, UT 84032
(435) 654-2226

Infiltration Rate

DATE 6/9/2022
DRAWN



This document and the information it contains is for information purposes only and shall not be used for design.

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

C:\Users\alecvandegraaff\Desktop\Heber Master Plan\groundwater_BACKUP.mxd 6/9/2022 11:27:35 AM alecvandegraaff

HORROCKS ENGINEERS

728 West 100 South
Heber, UT 84032
(435) 654-2226

Groundwater Depth

DATE 6/9/2022

DRAWN

Appendix E

(80th Percentile Calculations)

HEBER CITY NOAA RAINFALL DATA

PDS-based precipitation frequency estimates with 90% confidence intervals 1
Duration Average recurrence interval
https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut

	100	50	20	10	4	2	1	0.5	0.2	0.1
	1	2	5	10	25	50	100	200	500	1000
5-min	0.127	0.161	0.221	0.275	0.363	0.445	0.541	0.653	0.836	1
10-min	0.193	0.245	0.336	0.419	0.552	0.678	0.823	0.995	1.27	1.53
15-min	0.239	0.304	0.416	0.52	0.685	0.84	1.02	1.23	1.58	1.89
30-min	0.322	0.409	0.561	0.7	0.922	1.13	1.37	1.66	2.12	2.55
60-min	0.398	0.506	0.694	0.866	1.14	1.4	1.7	2.06	2.63	3.15
2-hr	0.504	0.628	0.825	1.01	1.31	1.59	1.91	2.3	2.94	3.52
3-hr	0.579	0.719	0.915	1.1	1.39	1.65	1.95	2.32	2.96	3.55
6-hr	0.764	0.941	1.16	1.35	1.63	1.87	2.14	2.44	3.01	3.59
12-hr	0.972	1.19	1.45	1.67	2	2.26	2.55	2.87	3.34	3.75
24-hr	1.18	1.46	1.77	2.03	2.4	2.69	2.99	3.3	3.73	4.06
2-day	1.37	1.69	2.05	2.34	2.75	3.06	3.38	3.71	4.16	4.5
3-day	1.53	1.88	2.27	2.6	3.04	3.39	3.75	4.11	4.6	4.98
4-day	1.68	2.07	2.5	2.85	3.34	3.72	4.11	4.51	5.04	5.45
7-day	2.01	2.47	2.98	3.4	3.96	4.39	4.84	5.29	5.88	6.33
10-day	2.29	2.82	3.39	3.84	4.44	4.89	5.34	5.78	6.35	6.77
20-day	3.02	3.72	4.45	5.01	5.73	6.26	6.78	7.27	7.89	8.32
30-day	3.67	4.5	5.34	5.99	6.81	7.4	7.97	8.51	9.18	9.65
45-day	4.6	5.65	6.68	7.47	8.46	9.16	9.83	10.4	11.2	11.7
60-day	5.47	6.71	7.91	8.8	9.91	10.7	11.4	12.1	12.8	13.3

PARK CITY NOAA RAINFALL DATA

PDS-based precipitation frequency estimates with 90% confidence intervals 1
Duration Average recurrence interval

	100	50	20	10	4	2	1	0.5	0.2	0.1
	1	2	5	10	25	50	100	200	500	1000
5-min	0.128	0.162	0.222	0.277	0.367	0.451	0.549	0.665	0.854	1.03
10-min	0.195	0.247	0.338	0.422	0.558	0.687	0.836	1.01	1.3	1.56
15-min	0.241	0.306	0.419	0.524	0.692	0.851	1.04	1.25	1.61	1.94
30-min	0.325	0.412	0.565	0.705	0.932	1.15	1.4	1.69	2.17	2.61
60-min	0.402	0.51	0.699	0.873	1.15	1.42	1.73	2.09	2.69	3.23
2-hr	0.515	0.641	0.839	1.02	1.33	1.61	1.95	2.34	2.99	3.59
3-hr	0.595	0.737	0.933	1.12	1.41	1.67	1.99	2.36	3.02	3.62
6-hr	0.793	0.975	1.19	1.39	1.68	1.92	2.19	2.51	3.09	3.65
12-hr	1.01	1.24	1.5	1.73	2.07	2.35	2.65	2.98	3.47	3.89
24-hr	1.31	1.6	1.92	2.18	2.55	2.84	3.13	3.44	3.84	4.16
2-day	1.56	1.92	2.3	2.62	3.05	3.38	3.73	4.08	4.55	4.91
3-day	1.74	2.14	2.57	2.93	3.43	3.81	4.21	4.62	5.16	5.59
4-day	1.92	2.36	2.84	3.25	3.8	4.24	4.69	5.15	5.78	6.27
7-day	2.32	2.86	3.43	3.91	4.57	5.08	5.6	6.13	6.84	7.39
10-day	2.65	3.26	3.9	4.41	5.09	5.6	6.11	6.61	7.27	7.76
20-day	3.47	4.27	5.06	5.67	6.46	7.03	7.59	8.13	8.79	9.27
30-day	4.2	5.15	6.08	6.8	7.72	8.39	9.04	9.66	10.4	11
45-day	5.16	6.32	7.44	8.31	9.43	10.2	11	11.8	12.7	13.3
60-day	6.13	7.52	8.83	9.84	11.1	12	12.9	13.7	14.7	15.4

DIFFERENCE

AVERAGE(0.5 X HEBER CITY / PARK CITY) = 0.47

0.496	0.497	0.498	0.496	0.495	0.493	0.493	0.491	0.489	0.485
0.495	0.496	0.497	0.496	0.495	0.493	0.492	0.493	0.488	0.490
0.496	0.497	0.496	0.496	0.495	0.494	0.490	0.492	0.491	0.487
0.495	0.496	0.496	0.496	0.495	0.491	0.489	0.491	0.488	0.489
0.495	0.496	0.496	0.496	0.496	0.493	0.491	0.493	0.489	0.488
0.489	0.490	0.492	0.495	0.492	0.494	0.490	0.491	0.492	0.490
0.487	0.488	0.490	0.491	0.493	0.494	0.490	0.492	0.490	0.490
0.482	0.483	0.487	0.486	0.485	0.487	0.489	0.486	0.487	0.492
0.481	0.480	0.483	0.483	0.483	0.481	0.481	0.482	0.481	0.482
0.450	0.456	0.461	0.466	0.471	0.474	0.478	0.480	0.486	0.488
0.439	0.440	0.446	0.447	0.451	0.453	0.453	0.455	0.457	0.458
0.440	0.439	0.442	0.444	0.443	0.445	0.445	0.445	0.446	0.445
0.438	0.439	0.440	0.438	0.439	0.439	0.438	0.438	0.436	0.435
0.433	0.432	0.434	0.435	0.433	0.432	0.432	0.431	0.430	0.428
0.432	0.433	0.435	0.435	0.436	0.437	0.437	0.437	0.437	0.436
0.435	0.436	0.440	0.442	0.443	0.445	0.447	0.447	0.449	0.449
0.437	0.437	0.439	0.440	0.441	0.441	0.441	0.440	0.441	0.439
0.446	0.447	0.449	0.449	0.449	0.449	0.447	0.441	0.441	0.440
0.446	0.446	0.448	0.447	0.446	0.446	0.442	0.442	0.435	0.432

The 80th Percentile Volume

LID Impact on Hydrology

Storm water programs have focused on the goal of mimicking predevelopment hydrologic conditions over the last several decades as municipal and department of transportation (DOT) storm water programs have increased their efforts to comply with the Federal Clean Water Act of 1972 and their associated MS4 permits. LID BMPs, green infrastructure practices, and retention of the 80th percentile volume or of the predevelopment hydrologic condition are tools and requirements that are used to accomplish this goal.

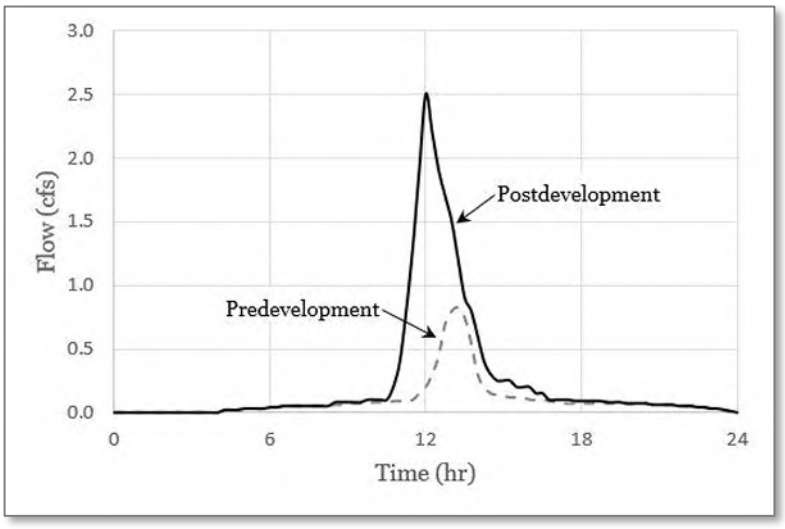


Figure 9: Typical hydrologic impact of development on-site hydrology.

More frequent peak flows, higher peak flows, and higher runoff volumes are well-documented hydrologic impacts of urbanization and development due to an increase in impervious surfaces (D.B. Booth, 1997; Konrad & Booth, 2002) (*Figure 9*).

Traditional approaches to storm water management that remove runoff from a site by quickly conveying flows to a storm drain network are also effective in protecting life and property and should be implemented in tandem with low impact design principles. Within Utah, discharges are typically limited to between 0.1 cfs and 0.2 cfs per acre.

An LID approach to site development produces a hydrologic condition that more closely mimics the pre-development hydrologic condition. Peak flows are reduced and are less frequent (*Figure 10*); runoff volume is also reduced (WEF Press, 2012).

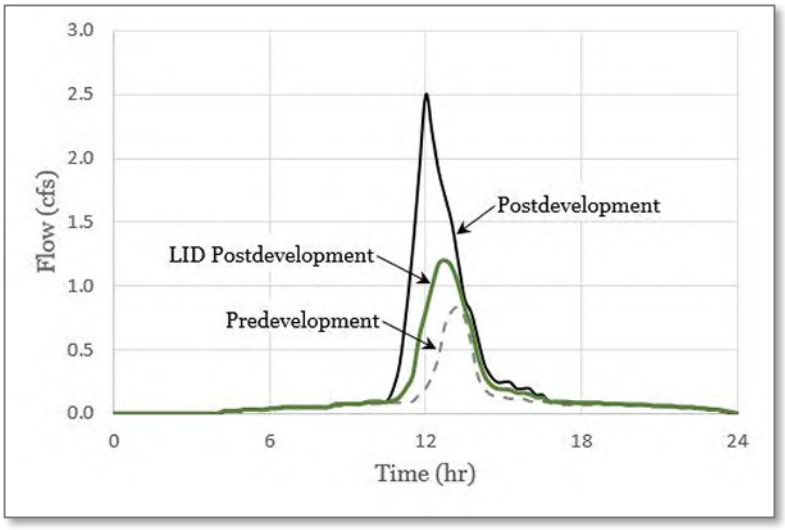


Figure 10: General post development hydrograph with LID.

Developing the 80th Percentile Volume

Project Volume Retention Goal, V_{goal}

V_{goal} for New Development: The volume of runoff generated within the project's limits of disturbance over a 24-hour period during the 80th percentile storm event or a predevelopment condition, whichever is less.

V_{goal} for Redevelopment: For a redevelopment project that results in a net increase in impervious surface greater than 10%, V_{goal} is the net increase in volume between the existing condition and the proposed condition generated by the 80th percentile storm event over a 24-hour period.

Water Quality Volume, WQV – The volume of runoff generated within a BMP's drainage area over a 24-hour period during the 80th percentile storm event.

The following steps may be used to determine the project volume retention goal and the water quality volume.

Step 1: 80th Percentile Depth

Method 1

A table of 80th percentile storm depths can be found in *Appendix A*. These values have been determined by the permittees.

Method 2

Planners and developers should verify with the MS4 before determining an 80th percentile with this method.

Determine the 80th percentile precipitation depth.

1. Obtain long-term daily rainfall data from the following sources:
    a. National Oceanic and Atmospheric Administration (NOAA): https://www.ncdc.noaa.gov/cdo-web/datatools/selectlocation; or
    b. Reliable historical local data; or
    c. Any other reliable data source.
2. Sort data low to high.
3. Remove snowfall and small precipitation events (≤0.1 inch).
4. Use the Excel PERCENTILE function to calculate the 80th percentile rainfall depth.

A more in-depth discussion on determining the 80th percentile precipitation depth is found here: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2019-004584.pdf.

A reliable record of historical precipitation data should meet the following conditions:

1. Come from an active rain gage;
2. Have at least 30 years of data;
3. Have 90% data coverage for the period of record.

Step 2: Imperviousness

To determine the project's volume retention goal, determine the imperviousness within the disturbance limits of the project. To determine the water quality volume of a BMP's drainage area, determine the imperviousness of the drainage area. The imperviousness of the BMP drainage area will include any off-site impervious areas that are part of the BMP's drainage area.

Project imperviousness = Post-development impervious area / Project's disturbance limits

BMP imperviousness = Post-development impervious area within BMP drainage area / BMP drainage area

Step 3: Volumetric Runoff Coefficient

Determine the volumetric runoff coefficient (R_V).

The volumetric runoff coefficient (also referred to as just the 'runoff coefficient') is a calculation of the percentage of rainfall that results in surface runoff. Runoff coefficients for small, frequent storms, such as for the 80th percentile, are not equivalent to runoff coefficients for large, less-frequent storms such as the 10-yr event and greater that are used with the Rational Method. The effects of infiltration, retention, and interception are increased for the smaller storm events compared to the larger events. Because of this, runoff coefficients for smaller storms are numerically smaller than for larger storms.

In 1983 data from over 50 sites nationwide was evaluated as part of the Nationwide Urban Runoff Program (NURP) (Driscoll, 1983). From these sites, mean and median R_V values were calculated and compared to the site's imperviousness. This research led to the following conclusions that are also discussed by Schueler who did additional analysis of the NURP sites:

1. "Most of the variation in mean R_V among sites can be attributed to differences in the level of urbanization, and in particular, to the site imperviousness."
2. "R_V's were found to be relatively consistent at individual sites and were only weakly correlated with storm-related variables such as precipitation volume, intensity, and duration."
3. "The runoff coefficient could serve as a reliable estimator of runoff volumes, given an initial estimate of rainfall volume." (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987)

Various coefficients for smaller storms have also been developed using national datasets and through local research. Municipalities are encouraged to research these and other runoff coefficients or develop their own in determining which method to use within their jurisdiction for use with the 80th percentile storm. Deciding on a single runoff coefficient methodology for a jurisdiction will simplify the design and review process.

Development of a runoff coefficient is done by monitoring the runoff volume produced from a storm event. The runoff coefficient is the ratio between the monitored runoff volume and the total precipitation volume expressed in the following equation and will vary depending on land use and imperviousness of the measured area:

$$R_V = \frac{V_R}{V_P}$$

Where:

R_V = Volumetric runoff coefficient, unitless

V_R = Monitored runoff volume, cf

V_P = Total precipitation volume, cf

The total precipitation volume can be determined using the following equation:

$$V_P = \frac{dA}{12}$$

Where:

d = Precipitation depth, in.

A = Drainage area, sf

It is not the intent of this manual or the Division of Water Quality to recommend specific methodologies. An in-depth summary of runoff coefficients used throughout the country by municipalities and DOTs was developed by the California Department of Transportation (Caltrans) and published as a Technical White Paper titled *Runoff Coefficient Evaluation for Volumetric BMP Sizing*. It can be found here: http://www.dot.ca.gov/design/hsd/guidance/CTSW-TM-15-312_03_01-Runoff_Coeff_for_Vol_BMP_Sizing.pdf. This white paper specifically discusses Method 1 in more detail.

For all the equations presented below, i represents the percent of imperviousness of the drainage area in decimal format (0.0 – 1.0).

Method 1 – Reese method

Comparing the imperviousness of 44 nationwide sites to their respective calculated volumetric runoff coefficient, a simple linear regression equation was created to estimate the volumetric runoff coefficient for small urban catchments. Land uses for these sites were classified as residential, mixed, commercial, industrial, and urban open and nonurban (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987). Outliers were removed from this dataset by Reese to derive the equation below. Removing outliers from the dataset reduces the impact of erroneous measurements (Reese, 2006).

$R_V = 0.91i - 0.0204$

Method 2 – Hydrologic soil groups

Regression equations for runoff coefficient equations were derived based on imperviousness and the NRCS hydrologic soil groups for the 2-year event as presented in *Table 5* (Guo, 2013).

Table 5: Runoff coefficient equations based on the NRCS Soil Group.

NRCS Soil Group		
A	B	C/D
$R_{V\text{-}A} = 0.84i^{1.302}$	$R_{V\text{-}B} = 0.84i^{1.169}$	$R_{V\text{-}C/D} = 0.83i^{1.122}$

Method 3 – Granato method

This runoff coefficient is calculated based on a two-line regression model of the runoff coefficient developed by the United States Geological Survey (USGS). This method of developing the runoff coefficient was developed to assist DOTs and contractors to estimate long-term volume reduction for highway projects and has been adopted for use by UDOT. Additional information relating to this runoff coefficient and its applicability can be found in NCHRP Report 792.

$R_V = 0.225i + 0.05$; when $i < 0.55$

$R_V = 1.14i - 0.371$; when $i \geq 0.55$

Step 4: 80th Percentile Volume

Calculate the 80th percentile volume using the following equations for V_{goal} or WQV.

$$V_{goal} = R_V dA \quad \text{or} \quad WQV = R_V dA$$

Where:

V_{goal} and WQV = 80th percentile volume, cf

R_V = Volumetric runoff coefficient, unitless

d = 80th percentile storm depth, ft (convert from inches to feet if required)

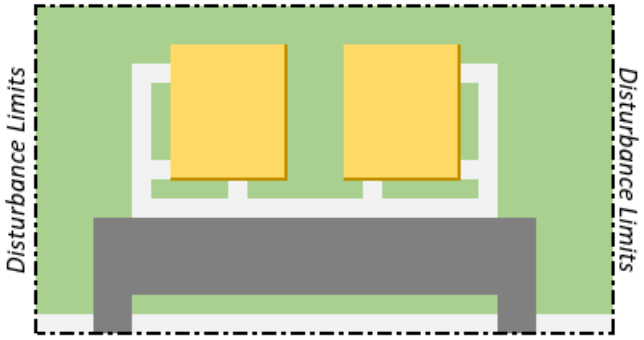
A = Project area or BMP drainage area, sf

The images on the following page show how V_{goal} and WQV are related. Examples from local case studies and different land uses further demonstrate the usage of these equations. See *Land Use Examples* and *Local Case Studies*.

V_{goal}

New Development

V_{goal} is the volume generated from the 80th percentile storm event over the entire project site or a predevelopment hydrologic condition, whichever is less.



$V_{goal} = R_V dA$

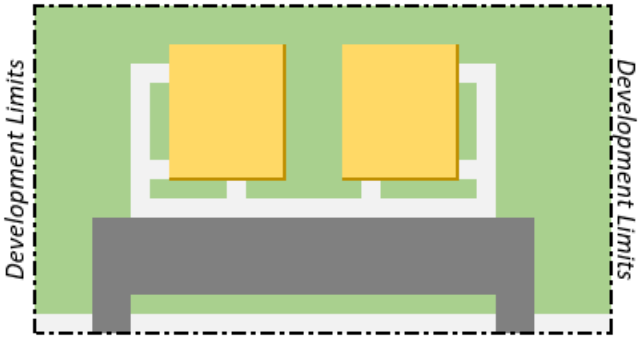
R_V = Volumetric runoff coefficient (based on the project's total area)

d = 80th percentile storm depth, ft

A = Project area, sf

Redevelopment

V_{goal} is the net volume increase generated from the 80th percentile storm event over the project area when the increase in impervious surface is greater than 10%.



Proposed Redevelopment
(Impervious surface increase > 10%)



$V_{goal} = V2 - V1$

$V_2 = R_V dA$

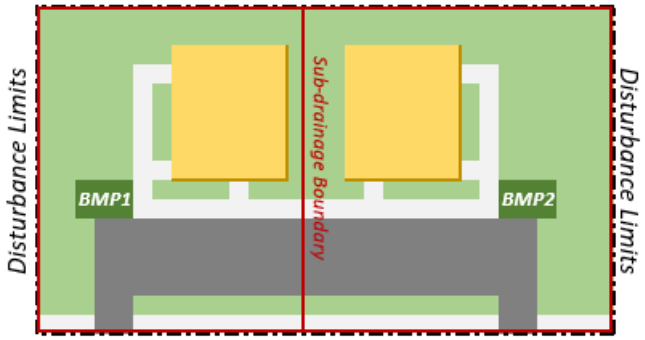
- Volume generated by the 80th percentile storm depth for the proposed project condition.

$V_1 = R_V dA$

- Volume generated by the 80th percentile storm depth for the existing project condition.

Water Quality Volume, WQV

The WQV is the 80th percentile volume of the sub-drainage area for each BMP.



Within the sub-drainage area boundaries, WQV is the 80th percentile volume based on the BMP's drainage area, the imperviousness of the BMP's drainage area, and the 80th percentile storm depth.

$WQV = R_V dA$

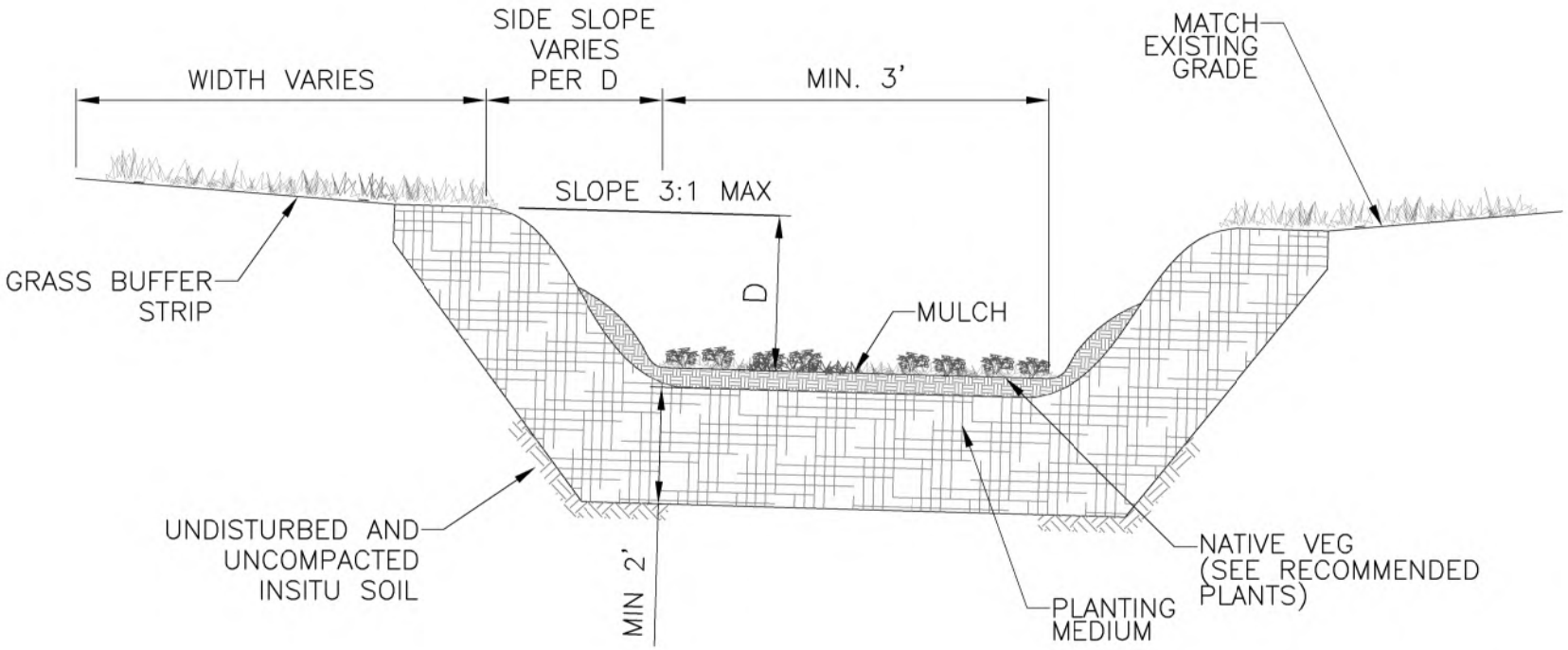
R_V = Volumetric runoff coefficient (based on the sub-drainage area's imperviousness)

d = 80th percentile storm depth, ft

A = Sub-drainage area, sf

Appendix F

(UCEA LID Details)



CALL BLUESTAKES
@ 1-800-662-4111 AT LEAST 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION

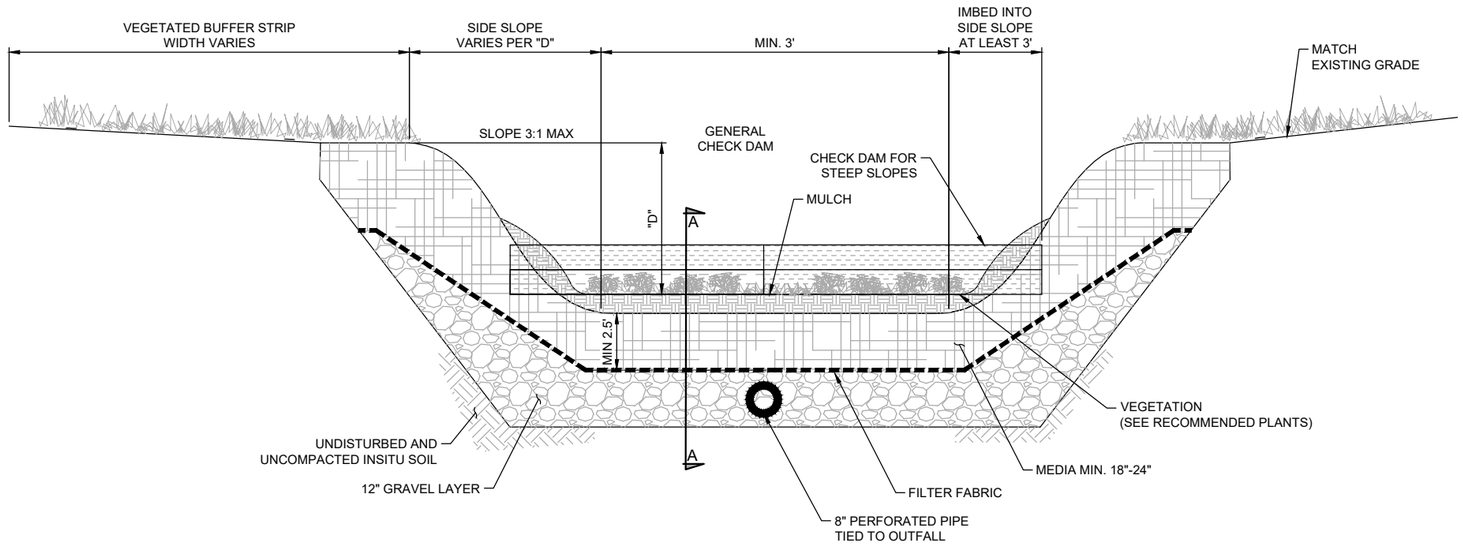
UCEA
UTAH CITY ENGINEERS ASSOCIATION

TYPICAL WET SWALE CROSS-SECTION

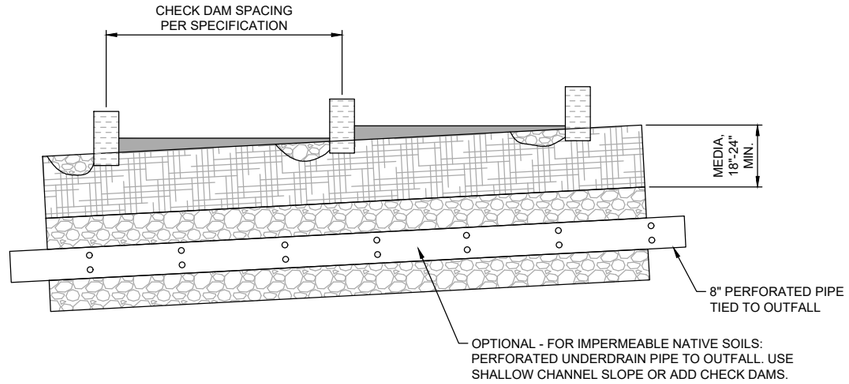
01_LID_StormwaterBMP_WetSwales

REVISIONS			
REV	DATE	BY	

DESIGNED UCEA	DATE 12/31/19	PROJECT NO. LID_01
DRAWN UCEA	DATE 12/31/19	SHEET NO. LID_01
CHECKED UCEA	DATE 12/31/19	DRAWING NO. LID_01



DRY SWALE SECTION



SECTION A

NOTE:

THIS DETAIL IS A MODIFIED VERSION OF UCEA STANDARD DRAWING.

XX / XX — TYPICAL DRY SWALE

03_LID_StormwaterBMP_Dry

REV	DATE	BY	DESCRIPTION

REVISIONS

SCALE

HORIZONTAL 1" = 2'

VERTICAL NONE

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

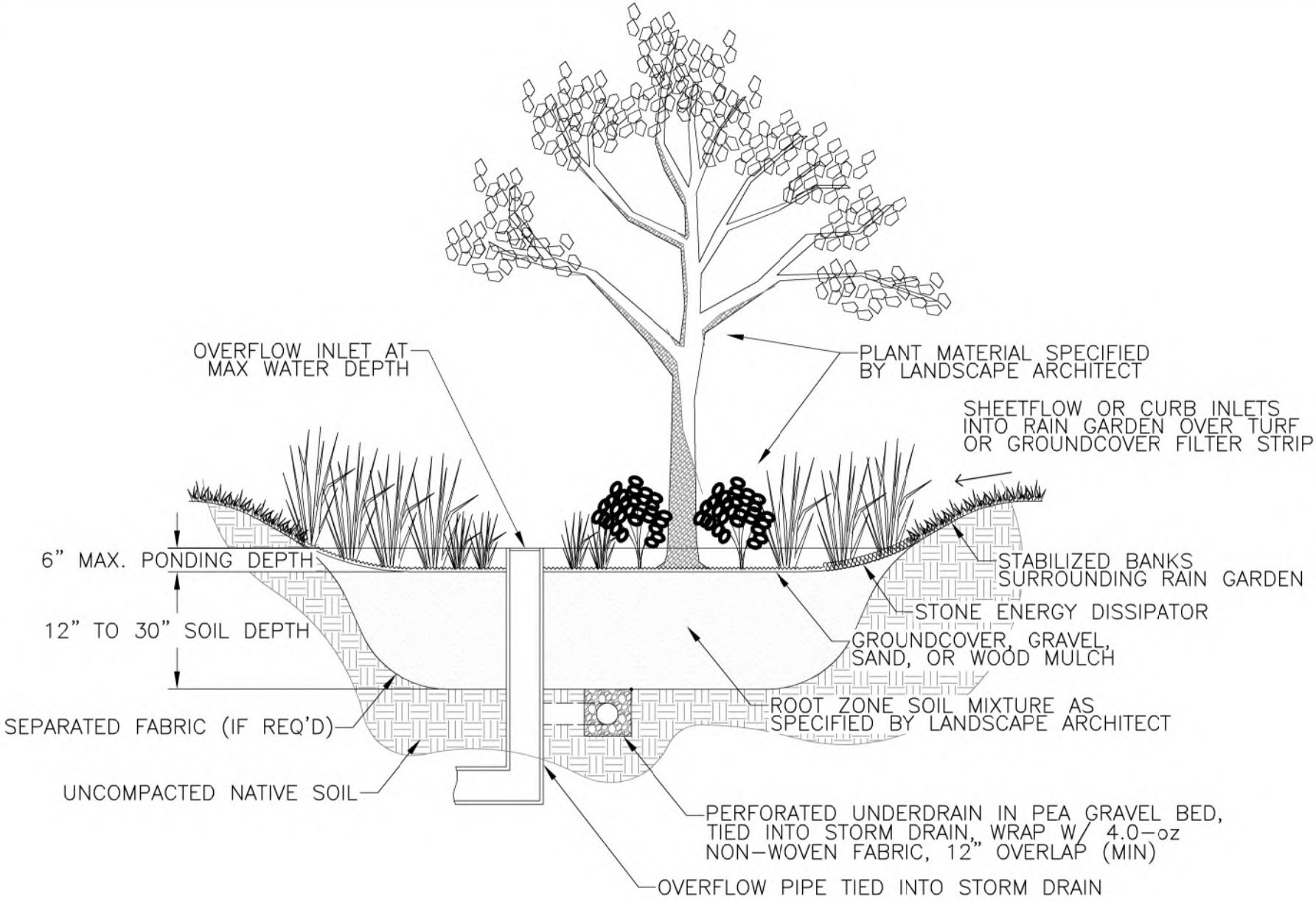
2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

####

####

DESIGNED	DATE	PROJECT NO.
####	####	####
DRAWN	DATE	SHEET NO.
####	####	#### OF ####
CHECKED	DATE	DRAWING NO.
####	####	01

H:\Heber City\City Projects\2020 North Village Master Plan\Storm Drain\Storm Drain Manual\Updated BMP Drawings\TYP DRY SWALE DETAILS.dwg - 01 - 5/11/2022 4:22 PM - lisa]



CALL BLUESTAKES @ 1-800-662-4111 AT LEAST 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION

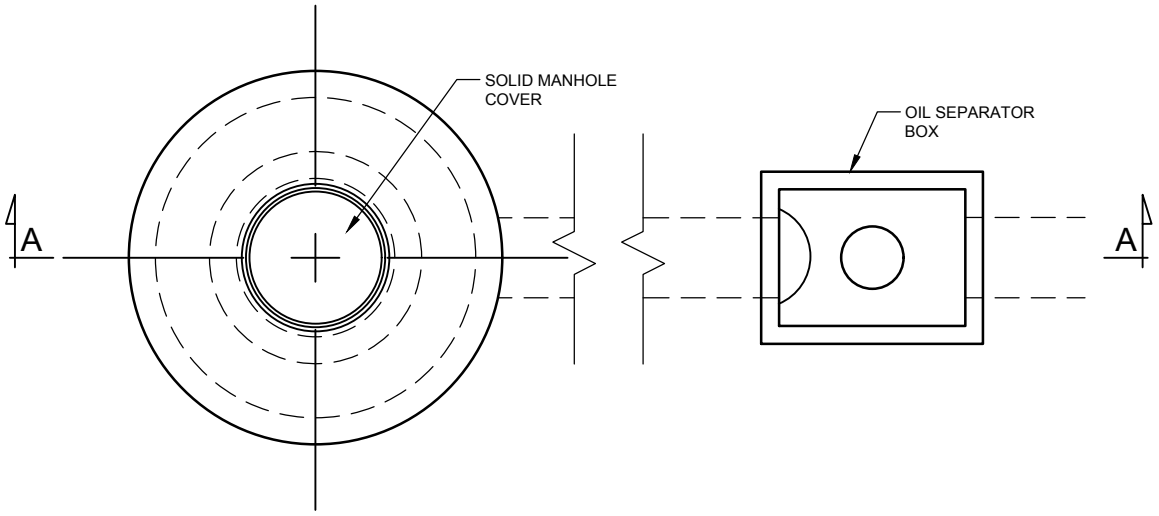
UCEA UTAH CITY ENGINEERS ASSOCIATION

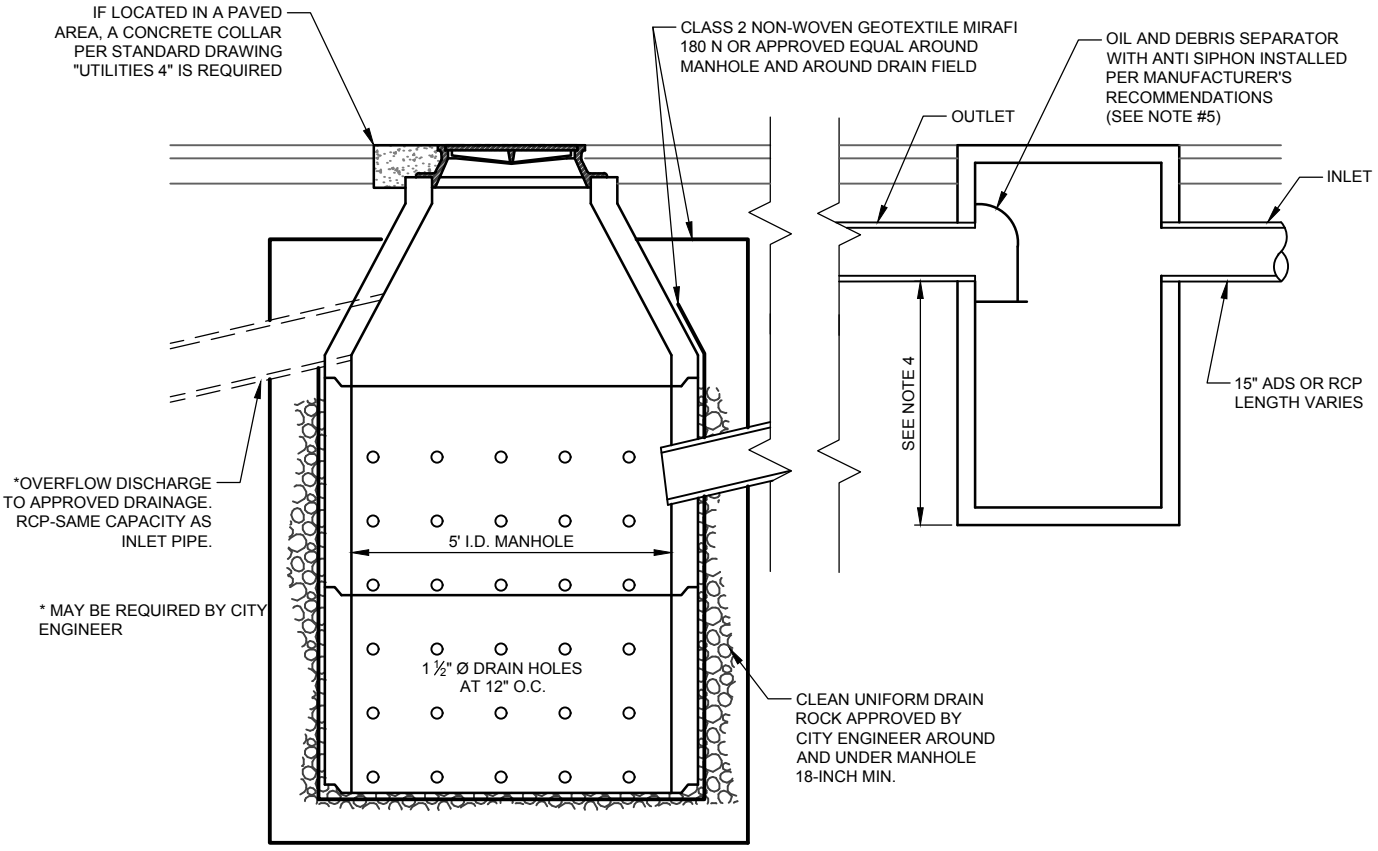
RAIN GARDEN

05_LID_StormwaterBMP_Rain_Garden

REVISIONS			
REV	DATE	BY	

DESIGNED UCEA	DATE 12/31/19	PROJECT NO. LID_05
DRAWN UCEA	DATE 12/31/19	SHEET NO. LID_05
CHECKED UCEA	DATE 12/31/19	DRAWING NO. LID_05





SECTION A-A

NOTES:

1. CONSTRUCT DROP INLET BOX TO MATCH WIDTH OF CURB & GUTTER. MATCH INSIDE LENGTH OF BOX TO INSIDE LENGTH OF FRAME.
2. D & L I-3516 WITH ADJUSTABLE CURB BOX.
3. STANDARD CAST IRON MANHOLE RING & LID.
4. SUMP DEPTH = 36" MIN. FOR 12" DIAMETER OUTLET AND SMALLER, FOR OUTLET DIAMETER 15" AND LARGER, DEPTH = 2.5 TO 3 TIMES THE DIAMETER.
5. SEE STANDARD SPECIFICATION 02772 PONDS.

SUMP DISPOSAL & OIL SEPARATOR

HORROCKS ENGINEERS
728 WEST 100 SOUTH #2
HEBER CITY, UTAH 84032
(435) 654-2226

DATE: FEBRUARY 2019
SCALE: N.T.S.

75 NORTH MAIN STREET
HEBER CITY, UTAH 84032
(435) 654-0757

HEBER CITY
HEART OF THE WASATCH BACK

HEBER CITY STANDARD DRAWING

STORM DRAIN-3

V:\ENGR\Stds\StdSpec\StdSpec 2019\Dwg Files\STORM DRAIN-3.dwg - Sump Oil - 2/06/2019 11:30am, rfunk

Appendix G

(TR-55 Worksheets)

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☐ acres ☐ mi^2 ☐ %	Product of CN x area
	Totals ➡					

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; **Use CN** ➡ ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q	in			

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID	
1. Surface description (table 3-1)		
2. Manning's roughness coefficient, n (table 3-1)		
3. Flow length, L (total L † 300 ft) ft		
4. Two-year 24-hour rainfall, P_2 in		
5. Land slope, s ft/ft		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr		+ =

Shallow concentrated flow

	Segment ID	
7. Surface description (paved or unpaved)		
8. Flow length, L ft		
9. Watercourse slope, s ft/ft		
10. Average velocity, V (figure 3-1) ft/s		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		+ =

Channel flow

	Segment ID	
12. Cross sectional flow area, a ft^2		
13. Wetted perimeter, p_w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15 Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18. ~~Flow~~ length, L ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		+ =
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr		

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = _____ mi^2 (acres/640)

Runoff curve number .....CN = _____ (From worksheet 2)

Time of concentration ..... T_c = _____ hr (From worksheet 3)

Rainfall distribution ..... = _____ (I, IA, II III)

Pond and swamp areas sprea
throughout watershed ..... = _____ percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr			
3. Rainfall, P (24-hour) ..... in			
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)			
5. Compute I_a / P			
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)			
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6			
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)			
9. Peak discharge, q_p ..... ft^3/s			

(Where $q_p = q_u A_m Q F_p$)

Worksheet 5a: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr rainfall P (in)	Runoff curve number CN	Runoff Q (in)	$A_m Q$ (mi^2—in)	Initial abstraction I_a (in)	I_a/P

From worksheet 3 | From worksheet 2 | From table 5-1

Worksheet 5b: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

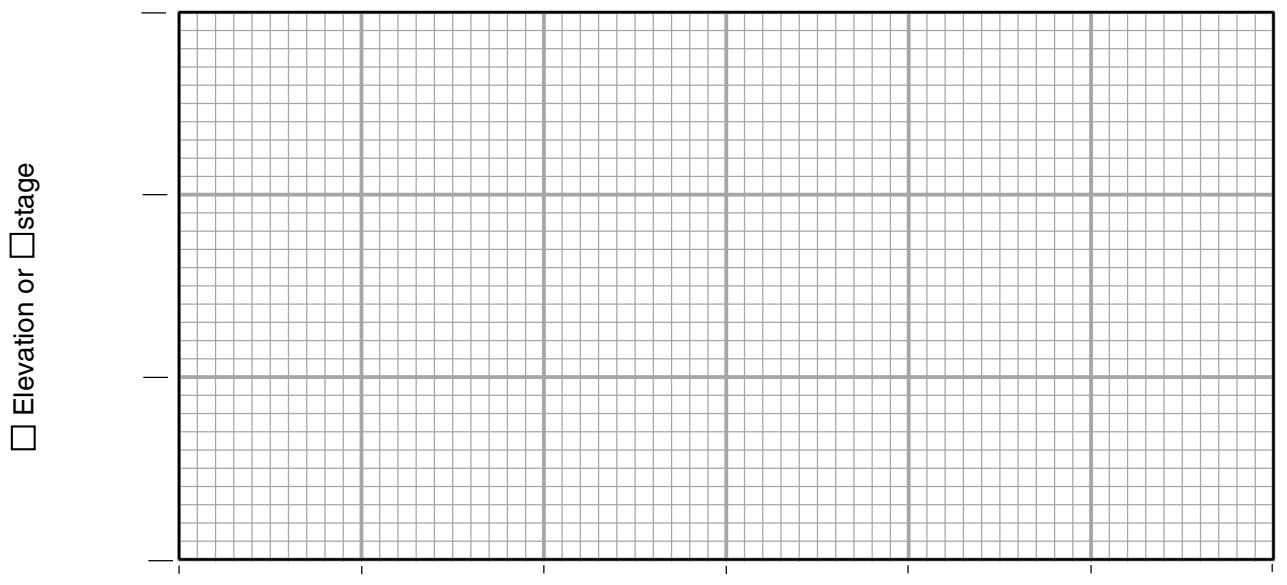
Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi^2—in)	Discharges at selected hydrograph times 3/ (cfs)											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area ..... A_m = _____ mi^2
   Rainfall distribution type (I, IA, II, III) = _____

	1st Stage	2nd Stage
2. Frequency ..... yr		
3. Peak inflow discharge q_i ..... ft^3/s (from worksheet 4 or 5b)		
4. Peak outflow discharge q_u ..... ft^3/s		1/
5. Compute $\frac{q_o}{q_i}$		

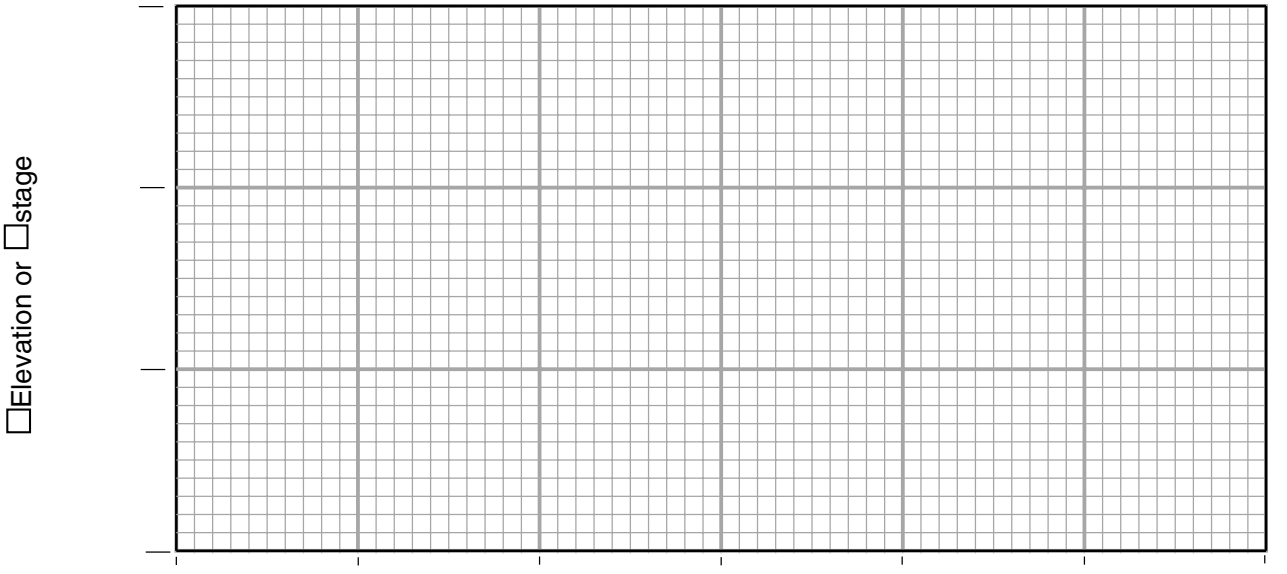
6. $\frac{V_s}{V_r}$ ..... (Use $\frac{q_o}{q_i}$ with figure 6-1)
7. Runoff, Q ..... in (From worksheet 2)
8. Runoff volume V_r..... ac ft ($V_r = QA_m$ 53.33)
9. Storage volume, V_s ..... ac-ft
   ($V_s = V_r \left(\frac{V_s}{V_r}\right)$)
10. Maximum storage E_{max} (from plot)

1/ 2nd stage q_o includes 1st stage q_o.

Worksheet 6b: Detention basin storage, storage volume (V_s) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area ..... A_m = _____ mi^2
   Rainfall distribution type (I, IA, II, III) = _____

	1st Stage	2nd Stage
2. Frequency ..... yr		
3. Storage volume V_s ..... ac-ft		
4. Runoff, Q ..... in (from worksheet 2)		
5. Runoff volume ..... ac-ft ($V_r = QA_m$ 53.33)		

1/ 2nd stage q_o includes 1st stage q_o.

6. Compute $\frac{V_s}{V_r}$ .....

7. $\frac{q_o}{q_i}$ ..... in
   (Use $\frac{V_s}{V_r}$ with figure 6-1)

8. Peak inflow discharge q_i ..... in
   (From worksheet 4 or 5b)

9. Peak outflow discharge q_o ..... ft^3/s 1/
   ($q_o = q_i$ ($\frac{q_o}{q_i}$))

10. Maximum storage E_{max} (from plot)

Appendix H

(Source Protection Maps)

Legend

- Broadhead Spring
- Fuel Tank
- Animal Feeding
- Golf Course
- Red Ledges Yard
- Septic System
- Other Wells

Broadhead Springs Zones

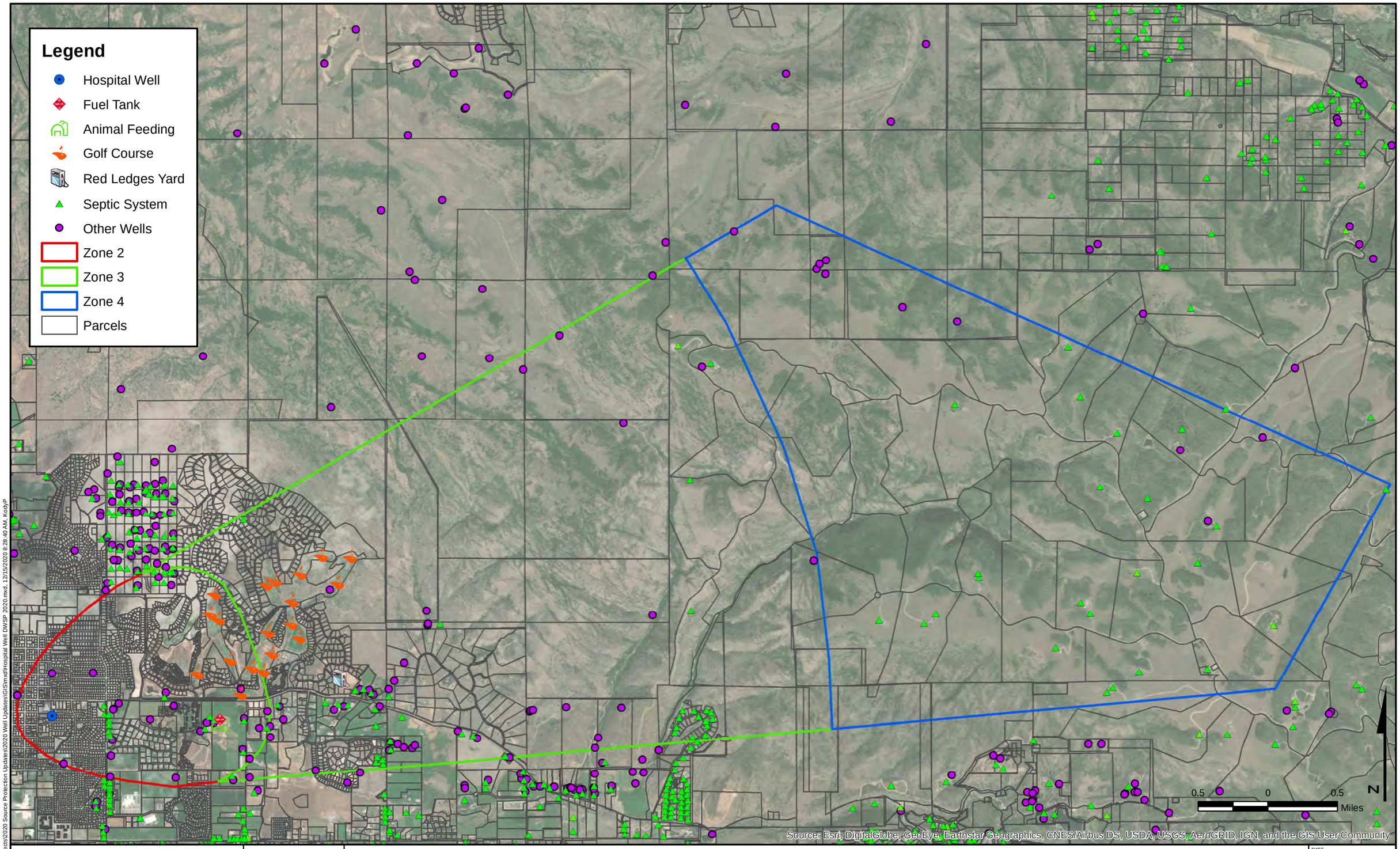
- Zone 2
- Zone 3
- Zone 4
- Parcels

HORROCKS ENGINEERS
2162 West Grove Parkway, Suite #400
Pleasant Grove, UT (801) 763-5100

Broadhead Springs Delineation Zones & PCS's

N
W E
S

1:36,000



H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Hospital Well DWSP 2020.mxd, 12/15/2020 8:28:40 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

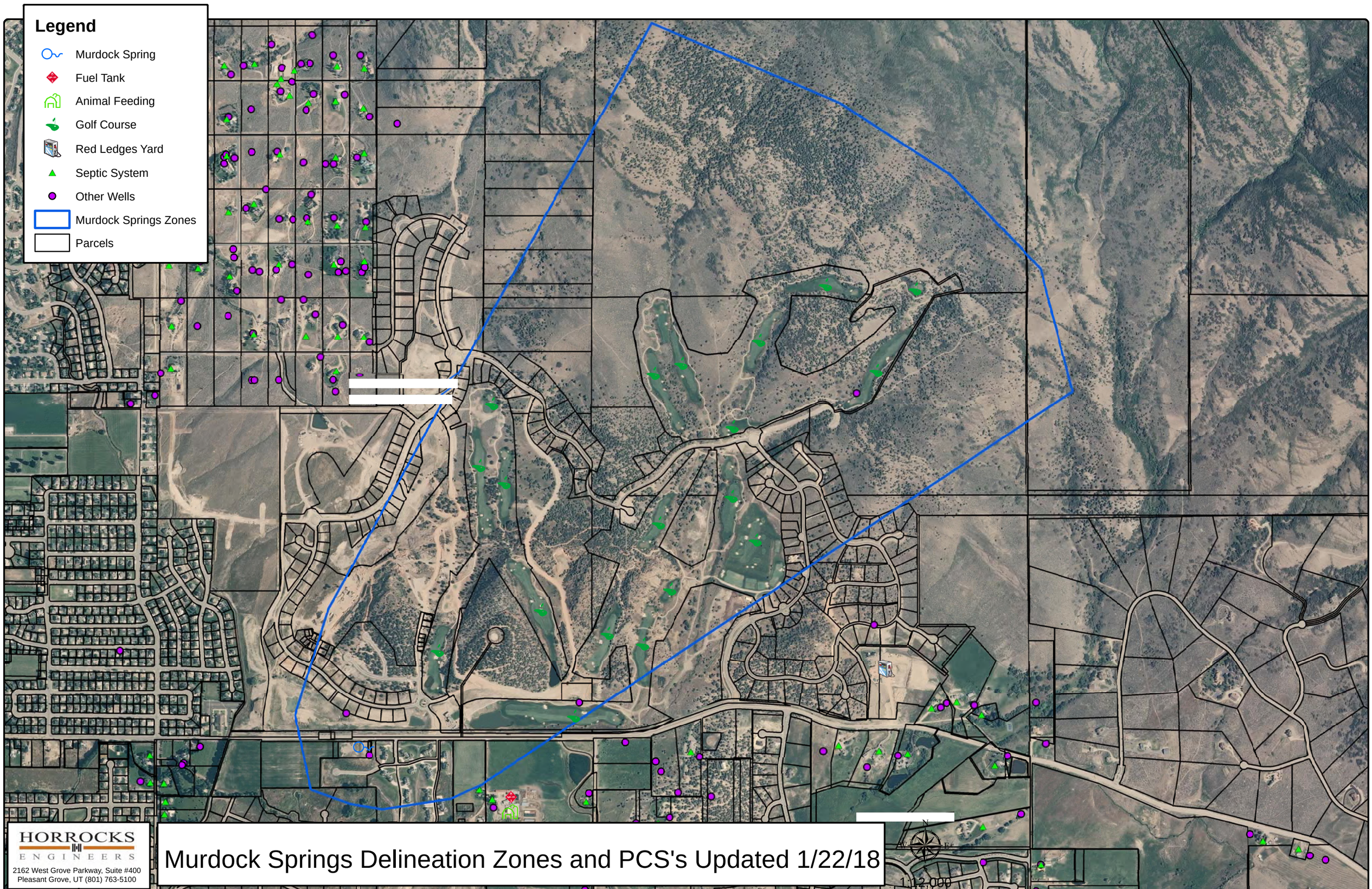
Hospital Well Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

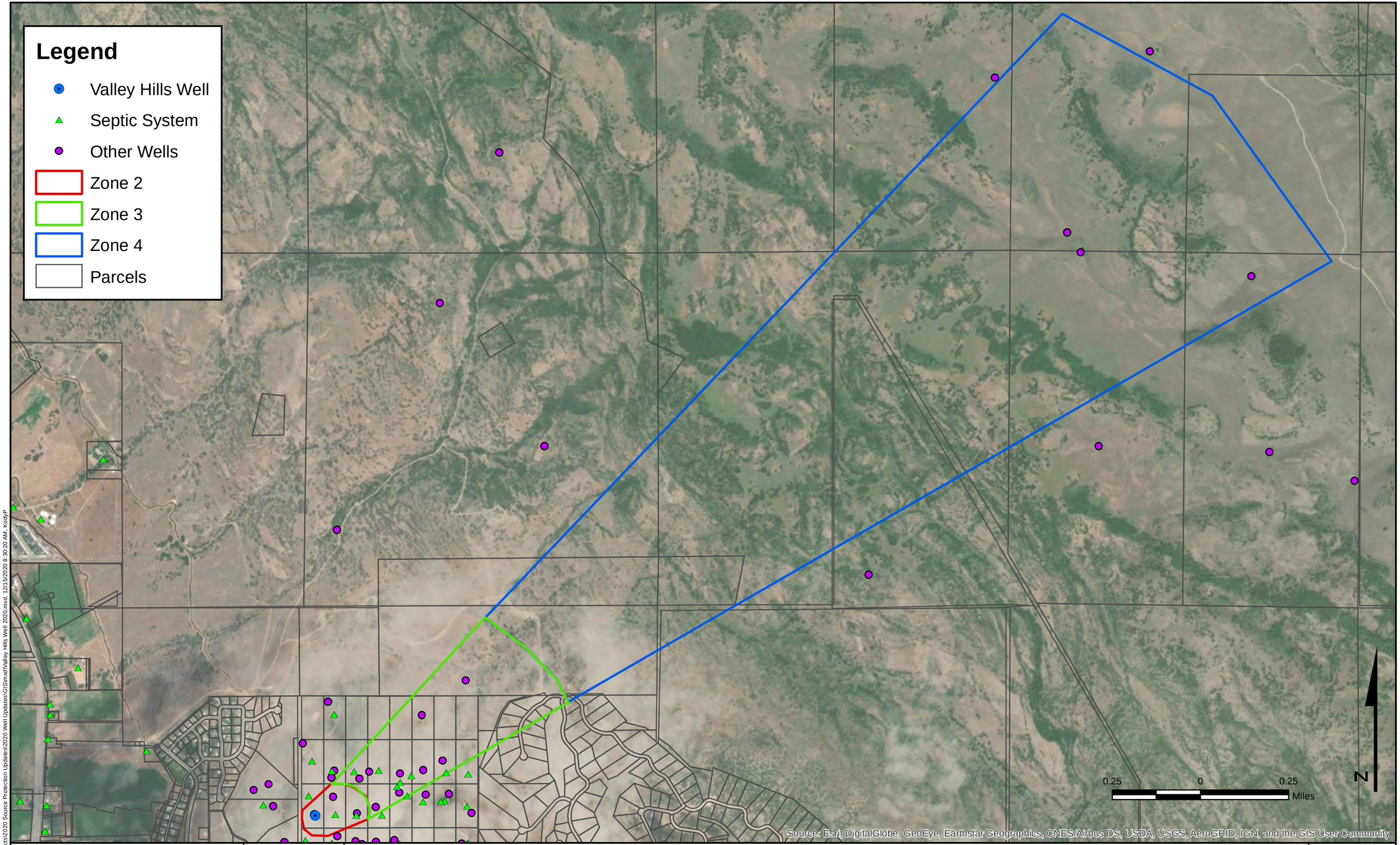
DRAWN

Figure 1



Murdock Springs Delineation Zones and PCS's Updated 1/22/18

HORROCKS ENGINEERS
2162 West Grove Parkway, Suite #400
Pleasant Grove, UT (801) 763-5100



H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Valley Hills Well 2020.mxd, 12/15/2020 8:30:20 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

Valley Hills Well Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

DRAWN

Figure 2

Legend

- Well #1
- Fuel Tank
- Animal Feeding
- Golf Course
- Red Ledges Yard
- Septic System
- Other Wells
- Zone 2
- Zone 3
- Zone 4
- Parcels

0.5 0 0.5 Miles

N

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Well #1 2020.mxd, 12/15/2020 8:35:43 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

Well #1 Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

DRAWN

Figure 3

Appendix I

(FAA Method Storage Facility Volume)

Obtain Excel file from City

Detention Pond Design
FAA Method with Guo Parameter

Runoff Coefficients		
Surface Type	Area	C
Hardscape	123805	0.9
Roof	56760	0.9
Landscape	83409	0.44
	263974	

Orifice Sizing		
Discharge	0.98	cfs
Head	4	ft
Orifice Coeff.	0.61	
Diameter	4.28	in

Basin Parameters		
Total Basin Area (A) =	9.8	acres
Connected Basin Area (A) =	6.06	acres
Weighted Coefficient (C) =	0.75	
Release Rate =	0.1	cfs/acre
Time of Concentration (tc) =	15	minutes

Pipe Volumes		
I.D. (in.)	Length	Vol. (cf)
0	0	0
0	0	0
		0

Time (min)	100-yr Rainfall (in)	100-yr Rainfall Intensity (in/hr)	Inflow Volume (cf)	Adjustment Factor	Outflow (cfs)	Outflow Volume (cf)	100-yr Required Detention Volume (cf)
5	0.54	6.52	9014	1.00	0.98	294	8720
10	0.83	4.96	13729	1.00	0.98	588	13141
15	1.02	4.08	16933	1.00	0.98	882	16051
20	1.14	3.42	18925	0.88	0.86	1029	17896
25	1.26	3.02	20917	0.80	0.78	1176	19741
30	1.38	2.76	22909	0.75	0.74	1323	21586
35	1.44	2.46	23822	0.71	0.70	1470	22352
40	1.49	2.24	24735	0.69	0.67	1617	23118
45	1.55	2.06	25648	0.67	0.65	1764	23884
50	1.60	1.92	26561	0.65	0.64	1911	24650
55	1.66	1.81	27474	0.64	0.62	2058	25416
60	1.71	1.71	28387	0.63	0.61	2205	26182
65	1.73	1.59	28678	0.62	0.60	2352	26326
70	1.75	1.50	28968	0.61	0.60	2499	26469
75	1.76	1.41	29259	0.60	0.59	2646	26613
80	1.78	1.34	29549	0.59	0.58	2793	26756
85	1.80	1.27	29840	0.59	0.58	2940	26900
90	1.82	1.21	30130	0.58	0.57	3087	27043
95	1.83	1.16	30421	0.58	0.57	3234	27187
100	1.85	1.11	30711	0.58	0.56	3381	27330
105	1.87	1.07	31002	0.57	0.56	3528	27474
110	1.89	1.03	31292	0.57	0.56	3675	27617
115	1.90	0.99	31583	0.57	0.55	3822	27761
120	1.92	0.96	31873	0.56	0.55	3969	27904
125	1.92	0.92	31902	0.56	0.55	4116	27786
130	1.92	0.89	31930	0.56	0.55	4263	27667

Simplied Rational Method Pond Sizing Template Calculation for 25-year Storm Event

Drainage areas	Sq. Ft	C Value
buildings	1	0.95
Aspahlt	1	0.95
Grass	1	0.15
Gravel	1	0.65
Concrete	1	1.00
Total	**5**	
Weighted C	0.740	
Infiltration min/in	1	
Safety Factor (2 minimum)	2	
Infiltration ft/min	0.0417	
Discharge per Acre (cfs) (Max=0.1)	0.1000	

25-yr Storm		
	in.	in/hr
5	0.36	4.36
10	0.55	3.32
15	0.69	2.74
30	0.92	1.85
60	1.14	1.14
120	1.31	0.65
180	1.38	0.46
360	1.62	0.27
720	1.97	0.16
1440	2.36	0.10

Mannings Calculation Spreadsheet			
Pipe D (in)	S (in/in)	n	
15	0.008	0.013	
V =	**4.72** ft/s		
Q =	**5.79** cfs		

Pipe Discharge	
	(cfs)
	0
	0
	0
	0
	0
	0
	0
	0
	0

	Depth (Ft)	Avg Length (Ft)	Avg Width (Ft)	Capacity (CF)
Pond Dimension				0
	Diam. (Ft)	**Depth (Ft)**		
Sump Manhole(s) (in the pond)			1	0
Drain Rock Around Sump MH (in pond)				0
Sump Manhole(s) (not in pond)				0
Drain Rock Around Sump MH (not in pond)				0
	Diam. (In)	**Length (Ft)**		
Underground Pipe Storage (no infiltration)				0
	Height (Ft)	**Length (Ft)**	**Avg Width (Ft)**	
Wrapped Drain Rock				0
	Height (Ft)	**Length (Ft)**	**Avg Width (Ft)**	
Underground Storage Chambers and Wrapped Drain Rock				

Drain Rock Void Ratio %	40
Will pond be Landscaped with Topsoil? (Y/N)	N
Will Underground Storage Chambers be under the pond? (Y/N)	N

Total Storage Capacity (CF)	0
Pond Exfiltr Surface (SF) (Must be zero if pond is landscaped with topsoil)	0
Underground Exfiltration Surfaces (SF)	0
Total Exfiltration Surface (SF)	0

Time (min)	Accum. Vol (CF)	Exfiltration (CF)	Discharge (CF)	Storage Req. (CF)	Max (CF)
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
30	0	0	0	0	0
60	0	0	0	0	0
120	0	0	0	0	0
180	0	0	0	0	0
360	0	0	0	0	0
720	1	0	0	0	0
1440	1	0	1	0	0
				Ultimate Demand	**0**

System is **Not Ok**

Notes:
Exfiltration from pond only allowed if the pond is not landscaped with topsoil. Only the bottom surface area of the pond may be used in exfiltration calculation.

Simplied Rational Method Pond Sizing Template Calculation for 100-yr Storm Event

Drainage areas	Sq. Ft	C Value
buildings	1	0.95
Aspahlt	1	0.95
Grass	1	0.15
Gravel	1	0.65
Concrete	1	1.00
Total	**5**	
Weighted C	0.740	
Infiltration min/in	1	
Safety Factor (2 minimum)	2	
Infiltration ft/min	0.0417	
Discharge per Acre (cfs) (Max=0.1)	0.1000	

100-yr Storm		
	in.	in/hr
5	0.54	6.49
10	0.82	4.94
15	1.02	4.08
30	1.37	2.75
60	1.70	1.70
120	1.91	0.96
180	1.94	0.65
360	2.12	0.35
720	2.52	0.21
1440	2.97	0.12

Mannings Calculation Spreadsheet			
Pipe D (in)	S (in/in)	n	
15	0.008	0.013	
V =	**4.72** ft/s		
Q =	**5.79** cfs		

Pipe Discharge	
	(cfs)
	0
	0
	0
	0
	0
	0
	0
	0
	0

	Depth (Ft)	Avg Length (Ft)	Avg Width (Ft)	Capacity (CF)
Pond Dimension				0

	Diam. (Ft)	Depth (Ft)	Quanity	
Sump Manhole(s) (in the pond)			1	0
Drain Rock Around Sump MH (in pond)				0
Sump Manhole(s) (not in pond)				0
Drain Rock Around Sump MH (not in pond)				0

	Diam. (In)	Length (Ft)	
Underground Pipe Storage (no infiltration)			0

	Height (Ft)	Length (Ft)	Avg Width (Ft)	
Wrapped Drain Rock				0

	Height (Ft)	Length (Ft)	Avg Width (Ft)	
Underground Storage Chambers and Wrapped Drain Rock				

Drain Rock Void Ratio %	40
Will pond be Landscaped with Topsoil? (Y/N)	N
Will Underground Storage Chambers be under the pond? (Y/N)	N

Total Storage Capacity (CF)	0
Pond Exfiltr Surface (SF) (Must be zero if pond is landscaped with topsoil)	0
Underground Exfiltration Surfaces (SF)	0
Total Exfiltration Surface (SF)	0

Time (min)	Accum. Vol (CF)	Exfiltration (CF)	Discharge (CF)	Storage Req. (CF)	Max (CF)
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
30	0	0	0	0	0
60	1	0	0	0	0
120	1	0	0	1	1
180	1	0	0	0	1
360	1	0	0	0	1
720	1	0	0	0	1
1440	1	0	1	0	1
				Ultimate Demand	**1**

System is **Not Ok**

Notes:
Exfiltration from pond only allowed if the pond is not landscaped with topsoil. Only the bottom surface area of the pond may be used in exfiltration calculation.

Guo, James C.Y. (1999). "*Detention Basin Sizing for Small Urban Catchments*," ASCE J. of Water Resources Planning and Management, Vol 125, No.6, Nov.

DETENTION BASIN SIZING FOR SMALL URBAN CATCHMENTS

by James C.Y. Guo, *PhD, P.E., Professor,*
Department of Civil Engineering, University of Colorado at Denver, Denver, Colorado.

Abstract
The Federal Aviation Administration (FAA) method for sizing small detention and retention basins is a volume-based approach that is sensitive to the release rate. In practice, such a release rate is often approximated by open channel hydraulics or culvert hydraulics. Without a consistent guideline, this practice of approximation can result in significant discrepancy or violation of the volume balance between the inflow and outflow hydrographs. In this study, a consistent procedure was developed to derive the average release from the allowable peak outflow. The required parameters for this method include peak inflow, design storm duration, and the time of concentration of the watershed. With this modification, the detention storage volume maximized by the FAA method can satisfy the volume conservation between hydrographs.

Key Words: Detention, Rational, FAA

INTRODUCTION

Urban stormwater facilities are designed to pass the peak flow through conveyance systems or to store a portion of the runoff volume in detention systems. For a small urban catchment with a tributary area less than 100 acres, the rational method is suitable for peak runoff predictions and the Federal Aviation Administration (FAA) method is recommended for detention storage volume predictions. The FAA's procedure is to maximize the required storage volume by the volume difference between the inflow and outflow volumes produced by a series of rain storms on the watershed. During the optimization process, the outflow volumes are calculated by an approximate average release from the detention basin. In current practice, there is not any guidance as to how to estimate the average release.

As a volume-based method, the FAA procedure has been widely used for small urban catchments in spite of its ambiguity in estimating the average release from the basin. For instance, the average release may be calculated by open channel flow, orifice formula, or culvert hydraulics. These hydraulic approaches result in violation of the hydrologic principle of volume conservation between the inflow and outflow hydrographs and inaccurate calculations on the required detention storage volume. To improve the current practice, this study suggests that the average release be a fraction of the allowable release rate. This fraction can be further derived by the volume conservation principle between inflow and outflow hydrographs during the maximization process. In this study, this ratio was found to vary with respect to storm duration, and is not a constant as recommended in many design criteria such as the Denver Design Criteria Manuals, and FAA Airfield and Heliports Design Criteria. The revised procedure can also be applied to other volume-based methods such as the capture runoff volume method (Guo and Urbonas, 1996) for sizing storm water quality control ponds. It provides a

consistent guideline to the estimation of the average release from a basin, and warrants volume conservation between the inflow and outflow hydrographs.

DETENTION STORAGE VOLUME BY THE FAA METHOD

The volume-based approach such as the FAA method is applicable to urban catchments with a tributary area less than 150 acres. To predict the peak runoff from such a small urban watershed, the Rational method states:

$$Q_d = \alpha C I_d A \tag{1}$$

The rainfall intensity in Eq 1 can be described as:

$$I_d = \frac{aP}{(b + T_d)^n} \tag{2}$$

in which α = unit conversion factor, equal to 1 for English units, and 1/360 for SI units, C = runoff coefficient, A= watershed area in acres (hectare), I_d = rainfall intensity in inch/hr (mm/hr), T_d = rainfall duration in minutes, Q_d= peak runoff rate in cfs (cms) and a, b, and n= constants on the Intensity- Duration- Frequency (IDF) formula.

Storm water detention process is to reduce the peak runoff and to delay the time to peak as well. In practice, the allowable release rate from a basin is defined by the downstream critical capacity, or the pre-development condition.
In this study, the average release is suggested to be a fraction of the allowable peak runoff, Q_a. Therefore, we have:

$$Q_m = mQ_a \tag{4}$$

in which Q_a = the allowable release which occurs at time T_a in Figure 1, Q_m = average release rate, and m = ratio of the average release to the allowable peak runoff rate. For a storm event, the detention storage volume is equal to the volume difference of the inflow and outflow as:

$$V_i = \alpha C I_d A T_d \tag{5}$$

$$V_o = Q_m T_d = mQ_a T_d \tag{6}$$

$$V_d = 60\left[\alpha C I_d A T_d - Q_m T_d\right] = 60\left[Q_d T_d - Q_m T_d\right] \tag{7}$$

in which V_i = inflow volume, V_o = outflow volume, and V_d = the required storage volume in cubic feet or cubic meter. The factor of 60 is to convert seconds to minutes. The reliability of Eq 7 depends on the specified average outflow in Eq 4. Without an adequate guidance, Eq 7 may lead to any result based on engineer's best estimation. Although an adjustment factor have been recommended to avoid underestimation of the detention volume by Urbonas and Stahle (1991) and Guo (1990), it is necessary to develop a consistent guideline for Eq 4.

MAXIMIZATION OF DETENTION STORAGE VOLUME

The peak runoff flow that occurs at the time of concentration, T_c is recommended for conveyance designs. It is well understood that the design storm duration for a detention basin is usually longer that T_c. As illustrated in Figure 1, the peak flow, Q_d, is produced by the design storm for the detention design. To estimate the required storage volume with no prior knowledge of the outlet hydraulics, it is suggested that the storage volume be calculated using the linear rising outflow hydrograph, i.e. line OB in Figure 1 (Malcom 1982) (Guo 1997). Based on the volume difference between the inflow and outflow hydrographs in Figure 1, the detention storage volume, i.e. the shaded area, is:

$$V_d = 60\left[Q_d T_d - \frac{Q_a}{2}(T_d + T_c) \right] \tag{8}$$

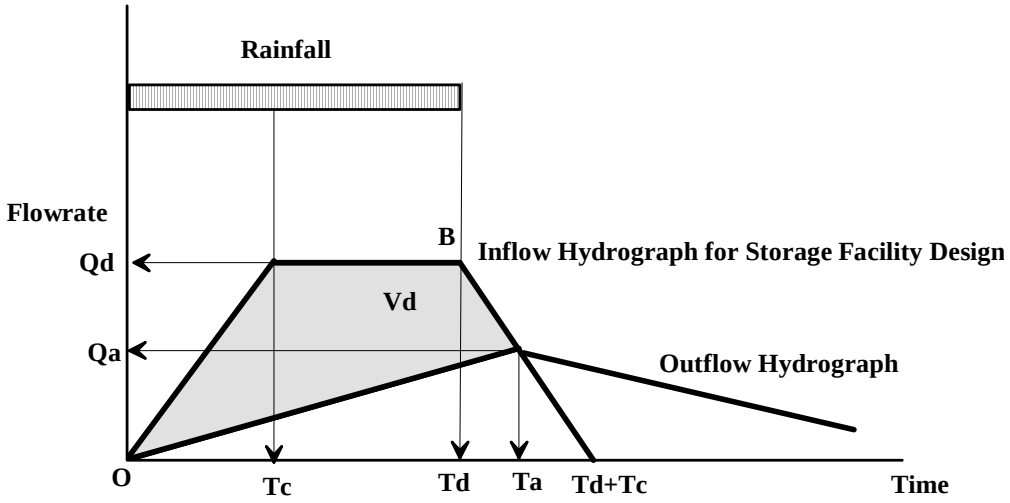


Figure 1. Detention Storage Volume Estimated by Hydrographs

Equating Eq 7 to Eq 8, the value of m is derived as:

$$m = \frac{1}{2}(1 + \frac{T_c}{T_d}) \quad \text{for } 0.5<m<1 \text{ and } T_d > T_c \tag{9}$$

Often the value of m is recommended to be a constant between 0.80 and 0.90 for all storm events (Urbanos and Stahre in 1991). Eq 19 indicates that the value of m varies with respect to the rain storm duration and can not be applied to a storm with duration less than T_c because the maximized operation of a detention basin requires the entire catchment to be tributary. The current practice does not have any limitation on storm duration and results in a maximization procedure starting from 5-minute rainfall. Eq. 9 begins with a value equal to unity when the storm duration is equal to T_c and then reduces to 0.5 when T_d is much longer than T_c. In comparison, the current practice of applying a constant value of m to all storm events can lead

to significant mistake. Substituting Eq 9 into Eq. 5 with the aid of Eq 3, the FAA method is modified to:

$$V_d = 60\left[\alpha C I_d A - \frac{Q_a}{2}(1+\frac{T_c}{T_d})\right]T_d \qquad (10)$$

The basic concept in the FAA method is to find the maximum volume difference between the inflow and outflow volumes under a series of storm events with different durations. Eq 10 shall be tested for a range of T_d until Eq 10 is maximized as:

$$V_m = 60\left[\alpha C I_m A - \frac{Q_a}{2}(1+\frac{T_c}{T_m})\right]T_m \quad \text{at } T_d = T_m \qquad (11)$$

where the subscript m represents the maximized solution.

DESIGN SCHEMATICS AND EXAMPLES

The example watershed used in this study is located in the City of Denver, Colorado. The 100-year IDF in Denver is specified by a = 74.1, b = 10, and n = 0.786. The developed watershed of 100 acres has a time of concentration of 25 minutes and runoff coefficient of 0.65. It produces a 100-year developed peak runoff of 296.86 cfs. The allowable release is 33% of the developed peak runoff. As a result, the allowable release rate is

$$Q_a = 0.33 Q_p = 97.96 \quad cfs \qquad (12)$$

The detention volumes for various periods of storm duration are calculated in Table 1. The maximized volume is found to be 8.52 acre-ft for this example.

Duration	Rainfall Intensity	Inflow Volume	Average Parameter	Average Outflow	Outflow Volume	Storage Volume
minutes	inch/hr	acre-ft	M	cfs	acre-ft	acre-ft
		Eq5	Eq 9	Eq 4	Eq 6	Eq 10
50.00	2.97	13.28	0.75	72.36	4.98	8.30
60.00	2.63	14.12	0.71	68.34	5.65	8.47
70.00	**2.37**	**14.83**	**0.68**	**65.47**	**6.31**	**8.52**
80.00	2.16	15.45	0.66	63.32	6.98	8.47
90.00	1.99	16.00	0.64	61.64	7.64	8.36

Table 1. Example for Maximization of Detention Volume.

CONCLUSIONS

Different hydrologic methods were developed for different hydrologic conditions. In the development of technical design criteria, it is a continual effort to maintain consistency among various design methods. The FAA method intends to be a simplified volume-based approach.

However, the current practice falls short in the estimation of the average outflow. This study presents a modification to the volume-based approach such as the FAA method so that the estimated detention volume can be consistent with the hydrograph method. Modifications to the FAA procedures shall not change its original intention as a simplified approach. As a result, this study applies the volume conservation principle between the simplified hydrographs to relate the average outflow as a fraction of the allowable release rate.

In this study, it was found that the average outflow can be determined by the allowable release from the basin, design storm duration, and the time of concentration of the watershed. In practice, the average release was often considered to be the average flow rate over the base time of the outflow hydrograph. This study indicates that this average outflow in fact is the equivalent average release rate that drains the basin storage volume over the storm duration time. Secondly, the ratio of average release to allowable release was not so constant as recommended by the current practice. Instead, it varies between one and 0.5, depending on storm duration. Applying a constant ratio to all storm events may result in a significant discrepancy against the volume conservation between the inflow and outflow hydrographs. Eq 9 provides a consistent guideline that modifies the current FAA procedures to satisfy the hydrograph volume balance.

APPENDIX I. REFERENCES

1. Adams County, Colorado. (1990) "*Storm Drainage Design and Technical Criteria*."

2. Department of the army and the Air Force. (1977) "*Surface Drainage Facilities for Airfields and Heliports*." Technical Manual No 5-820-1, Washington DC.

3. Federal Aviation Administration, Department of Transportation. (1970) "*Airport Drainage"*, AC No. 150/5320-5B.

4. Guo, James C.Y. (1977). "*Detention Basin Design and Sizing*. " Research Report, Department of Civil Engineering, University of Colorado at Denver, to be published by the Water Resources Publication, Inc. Littleton, Colorado.

5. Guo, James C.Y. and Urbona, Ben. (1996) "*Maximized Detention Volume Determined by Runoff Capture Ratio*." ASCE J. of Water Resources Planning and Management, Vol. 122, No. 1.

6. Malcom, H. Rooney. (1982) "*Some Detention Design Ideals.* " ASCE Proceedings of the Conference on Stormwater Detention Facilities, held in New England College, Hanniker, New Hampshire, edited by William DeGroot.

7. Shueler, Thomas R., and Helfrich, Mike. (1989) "*Design of Extended Detention Wet Pond System.* " Design of Urban Runoff Quality Controls, Edited by Larry A. Roesner, Ben Urbonas, and Michael B. Sonnen, American Society of Civil Engineers, New York, New York.

8. Urbonas, Ben and Stahre, Peter. (1991) "*Storm Water Detention.* " Prentice Hall, Englewood Cliffs, New Jersey.

135	1.93	0.86	31958	0.56	0.54	4410	27548
140	1.93	0.83	31986	0.55	0.54	4557	27429
145	1.93	0.80	32014	0.55	0.54	4704	27310
150	1.93	0.77	32043	0.55	0.54	4851	27192
155	1.93	0.75	32071	0.55	0.54	4998	27073
160	1.93	0.73	32099	0.55	0.54	5145	26954
165	1.94	0.70	32127	0.55	0.53	5292	26835
170	1.94	0.68	32156	0.54	0.53	5439	26717
175	1.94	0.66	32184	0.54	0.53	5586	26598
180	1.94	0.65	32205	0.54	0.53	5733	26472

Appendix J

(Storm Water Maintenance Agreement and Management Plan)

When recorded, mail to:
Heber City Recorder
75 North Main Street
Heber City, Utah 84032

LONG-TERM STORM WATER MAINTENANCE AGREEMENT
(Development Name)

THIS STORM WATER MAINTENANCE AGREEMENT (this "Agreement") is made and entered into this _____ day of _____, 2022, by and between Heber City, a municipal corporation of the State of Utah (the "City"); and _____ ("Owner") whose address is _____ Heber City, Utah 84032.

RECITALS

A. The City is authorized and required to regulate and control the disposition of storm and surface waters within the City, as set forth in the Heber City Code, as amended ("Ordinance"), and as adopted pursuant to the Utah Water Quality Act, as set forth in Utah Code Ann § 19-5-101, er seq., as amended (the "Act").

B. The Owner hereby represents and acknowledges that it is the owner in fee simple or is solely responsible through separate agreement(s) for storm water and its management from certain real properties more particularly described in Exhibit "A", attached hereto and incorporated herein by this reference (the "Property"), and in any amendments thereto, which property is subject to the regulations described above.

C. The Owner desires to build or develop the Property and/or to conduct certain regulated construction activities on the Property which will alter existing storm and surface water conditions on the Property and/or adjacent lands; and

D. To facilitate the anticipated development of the Property, the Owner desires to build and maintain, at Owner's expense, storm and surface water management facilities, including structures, improvements, grading and drainage plans and/or vegetation to control the quantity and quality of the storm water (the "Storm Water Facilities"); and

E. The Storm Water Facilities are shown in the final site plans for subdivisions accepted for the Property, in any related engineering drawings, and in any amendments thereto, which plans, and drawings are on file in the Heber City Engineering Department, and are hereby incorporated herein by this reference (the "Development Plan"); and

F. A detailed description of the Storm Water Facilities, which includes the operation and maintenance procedures required to enable the Storm Water Facilities to perform their designed functions (the "Long-Term Storm Water Management Plan"), is attached hereto as Exhibit "B". This plan is incorporated herein by this reference and may be amended from time to time by the City to comply with City's storm water management plan, MS4 UPDES permit, and other federal, state, and local requirements; and

G. As a condition of Development Plan acceptance, Owner is required to enter into this Agreement establishing a means of operating and documenting the execution of the Long-Term Storm Water Management Plan within the Property.

AGREEMENT

NOW, THEREFORE, in consideration of the benefits received, and to be received by the Owner, its successors, and assigns, as a result of the City's acceptance of the Long-Term Storm Water Management Plan the parties agree as follows:

1. Construction of Storm Water Facilities. The Owner shall, at its sole cost and expense, construct the Storm Water Facilities in strict accordance with the Development Plan, specifications, and any amendments thereto which have been accepted by the City or its agent.

2. Maintenance of Storm Water Facilities. The Owner shall, at its sole cost and expense, operate and maintain the Storm Water Facilities for flow from the property, and natural flow passing through the property, in strict accordance with the Long-Term Storm Water Management Plan. Owner's maintenance obligations shall be limited to structures, systems, and appurtenances on Owner's land, and facilities into which storm water flows outside of the public right-of-way, including all system and appurtenances built to convey storm water, as well as all structures, improvements, and vegetation provided solely to control the quantity and quality of the storm water. Maintenance, for purposes of this Agreement, is defined as good working condition so that the Storm Water Facilities are performing their design functions and capacities. The Owner shall, at its sole cost and expense, perform all work necessary to keep the Storm Water Facilities in good working condition.

3. Annual Maintenance Report. The Owner shall, at its sole cost and expense, submit an Annual Maintenance Report and Certification to the City of the Storm Water Facilities pursuant to the inspection schedule(s) in the Long-Term Storm Water Management Plan. The purpose of the Annual Maintenance Report and Certification is to assure safe and proper functioning of the Storm Water Facilities. The annual inspection shall cover all aspects of the Storm Water Facilities, including, but not limited to: parking lots, structural improvements, berms, channels, outlet structures, pond areas, access roads, vegetation, landscaping, etc. Deficiencies shall be noted in the Annual Maintenance Report. The Report shall also contain a Certification as to whether adequate maintenance has been performed and whether the structural controls are operating as designed to protect water quality. The Annual Maintenance Report and Certification shall be due by June 30, of each year and shall be in a form provided by the City with visual documentation, an example of which is attached in Exhibit "C" of the Long-Term Storm Water Management Plan, and that may be modified from time to time to accommodate laws, rules, and regulatory changes.

4. Oversight Inspection Authority. The Owner hereby grants permission to the City, its authorized agents and employees, to enter upon the Property and to inspect the Storm Water Facilities upon reasonable notice of not less than three business days to the Owner. The purpose of the inspection shall be to determine and ensure that the Storm Water Facilities are adequately maintained, are continuing to perform in an adequate manner, and are in compliance with all

applicable laws, regulations, rules, and ordinances, as well as the Long-Term Storm Water Management Plan.

5. **Notice of Deficiencies.** If the City or its agent finds the Storm Water Facilities contain any defects or are not being maintained adequately, the City or its agent shall send the Owner written notice of the defects or deficiencies and provide the Owner with reasonable time to cure such defects or deficiencies, stated in the notice. Such notice shall be sent certified mail to the Owner's address set forth below.

6. **Owner to Make Repairs.** The Owner shall, at its sole cost and expense, make such repairs, changes or modifications to the Storm Water Facilities as may be determined as reasonably necessary by the City or its agent within the required cure period to ensure the Storm Water Facilities are adequately maintained and continue to operate as designed and accepted.

7. **Corrective Action.** In the event the Owner fails to adequately maintain the Storm Water Facilities in good working condition acceptable to the City agent, the City or its agent may proceed with any enforcement mechanism provided in Heber City Code. The City or its agent may also give written notice that the Storm Water Facilities will be disconnected from the City's municipal separate storm sewer system. Any damage resulting from the disconnected system will be the Owner's responsibility. It is expressly understood and agreed that neither the City nor its agent are under any obligation to maintain or repair the Storm Water Facilities, and in no event shall this Agreement be construed to impose any such obligation on the City or its agent. The actions described in this Section are in addition to and not in lieu of the legal remedies available to the City as provided by law for Owner's failure to remedy deficiencies or any other failure to perform under the terms and conditions of this Agreement.

8. **Reimbursement of Costs.** In the event the City or its agent, pursuant to this Agreement, incurs any costs, or expends any funds resulting from enforcement or cost for labor, use of equipment, supplies, materials, and the like related to storm drain disconnection from the City's municipal separate storm sewer system, the Owner shall reimburse the City or its agent upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the City or it agent. After said thirty (30) days, such amount shall be deemed delinquent and shall be subject to interest at the rate of ten percent (10%) per annum. Owner shall also be liable for any collection costs, including attorney's fees and court costs, incurred by the City or its agent in collection of delinquent payments. The Owner hereby authorizes the City or its agent to assess any of the above-described costs, if remained unpaid, by recording a lien against the Property.

9. **Successors and Assigns.** This Agreement shall be recorded in the office of the County Recorder and the covenants and agreements contained herein shall run with the land and whenever the Property shall be held, sold, conveyed or otherwise transferred, it shall be subject to the covenants, stipulations, agreements and provisions of this Agreement which shall apply to, bind and be obligatory upon the Owner hereto, its successors and assigns, and shall bind all present and subsequent owners of the Property described herein. If the property is sold, the parties may execute an assignment of this Agreement and release of the seller's liability upon the City's consent and agreement.

10. **Severability Clause.** The provisions of this Agreement shall be severable and if any phrase, clause, sentence, or provision is declared unconstitutional, or the applicability thereof to

the Owner, its successors and assigns, is held invalid, the remainder of this Agreement shall not be affected thereby.

11. Utah Law and Venue. This Agreement shall be interpreted under the laws of the State of Utah. Suits for any claims or for any breach or dispute arising out of this Agreement shall be maintained in the appropriate court of competent jurisdiction in Salt Lake County, Utah.

12. Indemnification. This Agreement imposes no liability of any kind whatsoever on the City or its agent. The Owner hereby agrees to indemnify and hold the City and its officers, employees, agents and representatives from and against all actions, claims, lawsuits, proceedings, liability, damages, losses, and expenses (including attorneys' fees and court costs) that result from the performance of this agreement, but only to the extent the same are caused by any negligent or wrongful act or omissions of the Owner, and the Owner's officers, employees, agents, and representatives.

13. Amendments. This Agreement shall not be modified except by written instrument executed by the City and the owner of the Property at the time of modification, and no modification shall be effective until recorded in the office of the County Recorder.

14. Subordination Requirement. If there is a lien, trust deed or other property interest Recorded against the Property, the trustee, lien holder, etc., shall be required to execute a subordination agreement or other acceptable recorded document agreeing to subordinate their interest to this Agreement.

15. Exhibits and Recitals. The recitals set forth above and all exhibits to this Agreement are incorporated herein to the same extent as if such items were set forth herein in their entirety within the body of this Agreement.

[SIGNATURE PAGE TO FOLLOW]

IN WITNESS WHEREOF, the parties have signed and subscribed their names hereon and have caused this Agreement to be duly executed as of the day and year first set forth above.

OWNER

By: _____
Name: _____
Its: _____

OWNER ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF WASATCH)

On the ____ day of _____ 2022, before me _____ , personally appeared Michael Bradshaw, who being by me duly sworn, did say that he is the President of _____, a Utah corporation, and is authorized to execute the foregoing in its behalf and that he executed it in such capacity.

_____
NOTARY SIGNATURE

HEBER CITY

By: _____
Russell Funk, City Engineer

CITY ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF WASATCH)

On the ____ day of _____ 2022, before me _____ , Russell Funk who being by me duly sworn, did say that he is the City Engineer of Heber City, a political subdivision of the State of Utah, and that said instrument was signed in behalf of the City by authority of its City Council and said City Engineer acknowledged to me that the City executed the same.

_____
NOTARY SIGNATURE

EXHIBIT A
(Legal Descriptions)

Parcel ID# ??-??-???-???, LOT ... also described as:

BEGINNING...

AND

Parcel ID# ??-??-???-???, LOT ... also described as:

BEGINNING...

EXHIBIT B
(Long-Term Storm Water Management Plan)
(Separate Attachment)

EXHIBIT B

Long-Term Storm Water Management Plan

for

(Development Name)
Heber City, Utah

PURPOSE AND RESPONSIBILITY

As required by the Clean Water Act and resultant local regulations, including Heber City Storm water Management Program, those who develop land are required to build and maintain systems to minimize litter and contaminants in storm water runoff that pollute waters of the State.

This Long-Term Storm Water Management Plan (LTSWMP) describes the systems, operations and the minimum standard operating procedures (SOPs) necessary to manage pollutants originating from or generated on this property. Any activities or site operations at this property that contaminate water entering the City's storm water system or natural drainages are prohibited unless SOPs are written and accepted by the City to manage those activities or operations and amended into this LTSWMP.

The LTSWMP is aimed at protecting water quality and minimizing pollutants that could be generated by this property.

CONTENTS

SECTION 1: SITE DESCRIPTION, USE AND IMPACT

SECTION 2: TRAINING

SECTION 3: RECORDKEEPING

SECTION 4 APPENDICES

SECTION 1: SITE DESCRIPTION, USE AND IMPACT

The purpose of site infrastructure within the project is to control and contain pollutants which, if improperly managed, could adversely impact the environment. This LTSWMP includes standard operating procedures (SOP)s that are intended to direct maintenance operations and responsibly manage the grounds and infrastructure to ensure the chances of adverse impacts are minimized.

Parking, Sidewalk and Flatwork

Runoff from private roadways is the responsibility of the development. The development is also responsible for runoff from any private impervious areas or parking within the project. The various subdivisions within the project are made up of a variety of multi-family and single family lots ranging from approximately ?,000 square feet to ??,000 square feet. Each private lot has a concrete driveway. Any sediment, debris, fluids, or other waste left or that collect on these areas will be carried by runoff to the storm drain inlets. This waste material will settle in the storm drain system increasing maintenance cost and any material dissolving in the runoff will pass through the system. Maintenance involves regular sweeping, but it can also involve pavement washing to remove stains, slick spots, and oil/chemical spills when necessary. The Sweeping and the Pavement Washing SOPs are used to manage the pollutants associated with pavements.

Landscaping

This property's landscape operations can result in grass clippings, sticks, branches, dirt, mulch, fertilizers, pesticides, and other pollutants to fall or be left on paved areas. This waste material will settle in the storm drain system, increasing maintenance costs, and contributing to the solid and dissolved runoff waste that can pass through storm drain system and impact water quality. Primary pollutants of concern in the Heber area are nitrates and organic material, so it is vital that paved areas with direct connection to the City storm drain systems remain clean of landscape debris. The Landscape Maintenance SOP is written to control and manage this potential pollution source.

Storm Drain System

Storm water inlets are located within the curb and gutter of private roads and parking areas. These inlets direct all runoff from the development (developed flow) into privately maintained ponds and infrastructure. In cases where developed flow from these areas is mixed with developed flow from public roads and retained in ponds on private property, the ponds and infrastructure will be privately maintained. Maintenance will include cleaning, repair, and replacement of the facilities.

Storm water in natural drainages passing through the property (undeveloped flow) will be kept separate from storm water generated by the development. Where the natural undeveloped storm water flow is retained in ponds at roads or other crossings on private property, these ponds and infrastructure will be privately maintained. Maintenance will include cleaning, repair, and replacement of the faculties.

In cases where developed storm water flow is retained and subsequently discharged into City infrastructure downstream, the development is responsible for the quantity and quality of the storm water prior to entering the City's system.

Waste Management

Trash receptacles with lids are intended to prevent exposure to precipitation which minimizes liquids that can leak onto pavements and into the storm drain system. They also minimize the amount of light weight trash that is exposed to wind and scattered along the ground. Good waste management systems, if managed improperly, can end up as the source of the very pollution that they were intended to control. The Waste Management SOP is written to control and manage waste.

Snow and Ice Removal Management

Salt is a necessary material for ensuring safe parking and pedestrian walkways. However, snow removal operations, if improperly managed, will have an adverse impact on vegetation and local water resources.

SECTION 2: TRAINING

The purpose of training is to ensure that all homeowners and maintenance contractors know and understand the SOPs that are specifically written to manage and maintain the property. Maintenance contractors must follow good practices and meet the minimum standards described in the LTSWMP SOPs. A file of all training records in Appendix C will be maintained for review.

SECTION 3: RECORDKEEPING

Maintain records of operation and maintenance activities in accordance with SOPs. Mail a copy of the record to Heber City annually by June 30th of each year.

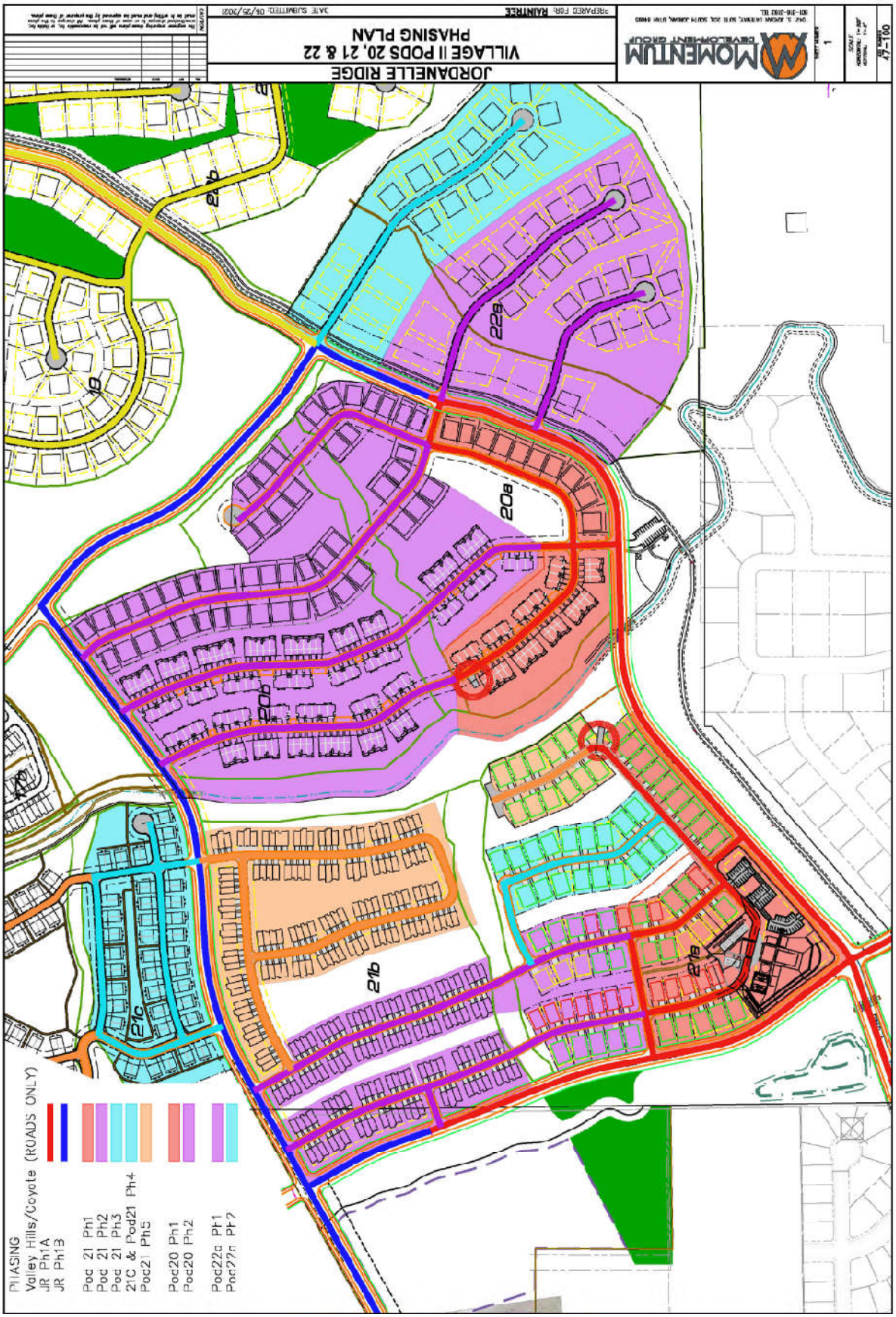
SECTION 4: APPENDICES

Appendix A- Infrastructure Locations, Site Drawings, and Details

Appendix B- SOPs

Appendix C- Recordkeeping Documents

APPENDIX A – INFRASTRUCTURE LOCATIONS, SITE DRAWINGS, AND DETAILS



APPENDIX B – SOPs

Pavement Maintenance Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Purpose and Selection:**
   a) Reduce storm water pollution by sweeping and removing pollutants that will be carried to City storm water systems during storm water runoff or by non-storm water runoff.
   b) The sweeper is intended for removing material that collects on pavements by use and the natural degradation of pavements, i.e., material that collect, drop from vehicles and the natural erosion and breaking up of pavements.

2. **Regular Procedure:**
   a) Remain aware of debris and sweep minor debris is needed by hand.
   b) Generally sweeping machinery should be used during autumn when leaf fall is heavy and early spring after winter thaw. Sometimes sweeping machinery will be necessary when accumulations are spread over a large area of the pavement.
   c) Manage outside activities that leave waste or drain pollutants to pavements. This involves outside functions including but not limited to: Yard sales, yard storage, fund raisers, etc. Do not allow car wash fund raiser or other activities that allow detergents or other pollutants to be wash into storm drain systems.

3. **Disposal Procedure:**
   a) Service contractors to dispose at licensed facilities.
   b) Dispose of hand collected materials in dumpsters.

4. **Training:**
   a) Annually and at hiring.

Landscape Maintenance Operations

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

Rule: Prevent any solids, liquids, or light weight material from being carried away from the construction or maintenance envelop by wind or water.

5. Application:

a) This SOP should provide sufficient direction for many of the general landscaping operations, e.g., fertilizer and pesticide applications, mowing, weeding, tree trimming, digging, sprinkler repairs, varying landscape cover management, etc.

6. Maintenance Procedure:

a) Grooming

- Lawn Mowing - Immediately following operation, sweep or blow clippings onto vegetated ground.
- Fertilizer Operation - Prevent overspray. Sweep or blow fertilizer onto vegetated ground immediately following operation.
- Pesticide Operation - Prevent overspray, use spot treatment, sweep, or blow dry pesticide onto vegetated ground immediately following operation.

b) Remove or contain all erodible or loose material prior forecast wind and precipitation events before any non-storm water will pass through and over the project site and at end of work period. Light weight debris and landscape materials require immediately attention when wind expected.

c) Landscape project materials and waste can usually be contained or controlled by operational best management practices.

- Operational; including but not limited to:
  - Strategic staging of materials eliminating exposure, such as not staging on pavement
  - Avoiding multiple day staging of landscaping backfill and spoil on pavements
  - Haul off spoil as generated or daily
  - Scheduling work when weather forecast are clear.

d) Cleanup:

- Use dry cleanup methods, e.g., square nose shovel and broom. It is usually sufficient when no more material can be swept onto square nosed shovel.
- Power blowing tools

7. **Waste Disposal:**
   a) Dispose of waste according to General Waste Management SOP, unless superseded by specific SOPs for the operation.

8. **Equipment:**
   a) Tools sufficient for proper containment of pollutants and cleanup.
   b) Push broom and square blade shovel should be a minimum.

9. **Training:**
   a) Annually and at hiring
   b) Landscape Service Contractors must have equal or better SOPs.

Waste Management Operations

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Application:**
   a) This SOP is for all Staff, intended for the proper disposal of common everyday waste.

2. **Waste Collection Devices (Exposed units):**
   a) The site contains the following types of waste management containers.
      - Receptacles with lids

3. **Waste Disposal Restrictions for all waste Scheduled for the Landfill:**
   a) Generally, most waste generated at this property, and waste from spill and clean up operations can be disposed in dumpsters under the conditions listed in this SOP. Unless other disposal requirements are specifically identified by the product SDS or otherwise specified in other SOPs.
   b) Know the facility disposal requirements and restrictions. It should not be assumed that all waste disposed in collection devices will be disposed of at the landfill.
   c) Review landfill regulations for additional restrictions and understand what waste is prohibited. Ensure the SDS and Landfill regulations are not contradictory. Generally, the waste prohibited by the landfill is:
      - Liquid:
        - paint
        - pesticides/fertilizers
        - oil (all types)
        - antifreeze
        - batteries
        - liquid chemicals
        - etc.

        (Generally, *all the above hazardous waste when involved in minor spill cleanup operations can be disposed in covered dumpsters and our waste bays, if the liquid is contained in absorbent material, e.g. sand, dirt, loose absorbent, pads, booms etc., and transformed or dried such that it will not drip. This is not intended for wholesale disposal of out dated or spent liquid hazardous waste. When disposal of outdated or spent liquid is*

needed or for questions of how to dispose of other waste, contact the Health Department for instructions and locations.

4. **Waste Disposal Required for Landfill or Other:**
   a) Generally, for waste not accepted by the landfill.
   b) Follow SDS for disposal requirements. Review landfill regulations for additional restrictions and understand what waste is prohibited. Ensure the SDS and Landfill regulations are not contradictory
   General rules are:
      - Get approval prior to delivery.
      - Transport waste in secure leak proof containers that are clearly labeled.
   c) Lookup and follow disposal procedures for disposal of waste at other EPA approved sites.

5. **General Staff Maintenance Practices:**
   a) Prevent dumpsters and receptacles from becoming a pollution source by:
      - Closing lids
      - Reposition tipped receptacles upright.
      - Report full or leaking and unsecured dumpsters and receptacles to the company provider or repair it in house. Determine source liquids and prevent it.
      - Report any eminent pollutant hazard related to dumpsters and receptacles to the owner.

6. **Training:**
   a) Annually and at hiring

Storm Drain Maintenance Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Procedure:**
   a) Inspect for need:
      - Schedule cleaning for boxes and pipe that contain 2" or more of sediment and debris.
      - Remove debris by vacuum operated machinery.
      - When accumulations are mostly floating debris this material can be removed with a net.
      - Inspect standing water for mosquito larvae and contact the mosquito abatement district when necessary.

2. **Disposal Procedure:**
   a) Dispose of waste collected by machinery at regulated facilities.
   b) Floating materials and floating absorbent materials may be disposed in dumpster when dried out. Dry dirt and slurry may also be disposed in the dumpster.
   c) Disposal of hazardous waste
      - Dispose of hazardous waste at regulated disposal facilities, see Waste Management and Spill Control SOP
   d) Disposal of waste collected from sanitary sewer device at regulated facilities.

3. **Training:**
   a) Annually and at hire

Pavement Washing Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Procedure:**
   a) Prevent waste fluids and any detergents if used from entering storm drain system. The following methods are acceptable for this operation.
      - Dam the inlet using a boom material that seals itself to the pavement and pick up the wastewater with shop-vacuum or absorbent materials.
      - Collect wastewater with shop-vacuum simultaneous with the washing operation.
      - Collect wastewater with vacuum truck or trailer simultaneous with the washing operation.
   b) This procedure must not used to clean the initial spills. First apply the Spill Containment and cleanup SOP.

2. **Disposal Procedure:**
   a) Small volumes can usually be drained to the local sanitary sewer. Contact the South Valley Sewer District.
   b) Large volumes must be disposed at regulated facilities.

3. **Pavement Cleaning Frequency:**
   a) There is no regular pavement washing regimen. Pavement washing is determined by conditions that warrant it, including but not limited to: prevention of slick or other hazardous conditions or restore acceptable appearance of pavements.

4. **Training:**
   a) Annually and at hiring

Snow and Ice Removal Management

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Application:**
   a) Parking and sidewalk winter management operations.

2. **De-Icing Procedure:**
   a) Do not store or allow salt or equivalent to be stored on outside paved surfaces.
   b) Minimize salt use by varying salt amounts relative to hazard potential.
   c) Sweep excessive piles left by the spreader.
   d) Watch forecast and adjust salt amounts when warm ups are expected the same day.

3. **Training:**
   a) Annually and at hiring.
   b) Require snow and ice service contractors to follow the stronger of this SOP or their company SOPs.

Spill Control

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Rational:**
   a) All properties are susceptible to spills whether it is a result of operations or by customers. Insufficient response, inadequate containment materials and improper spill cleanup methods will result in pollutants in our waterways. Once the pollutants reach our storm drain system, or even the detention pond, they are difficult and expensive to remove.

2. **Containment Procedure:**
   a) Priority is to dam and contain flowing spills.
   b) Use spill kits booms if available or use any material available; including but not limited to, nearby sand, dirt, landscaping materials, etc.
   c) Hazardous or unknown waste material spills
      - Critical Emergency constitutes large quantities of flowing uncontained liquid that will affect areas with people or reach storm drain systems. Generally burst or tipped tanks. Call Hazmat, DWQ, Health Department, and City.
      - Minor Emergency constitutes a spill that has reached a storm drain but is no longer flowing. Call Health Department, and City
      - Spills that are contained on the surface and do not meet the criteria for Critical and minor emergencies may be managed by the responsible implementation of this SOP.

3. **Cleanup Procedure:**
   a) NEVER WASH SPILLS TO THE STORM DRAIN SYSTEMS.
   b) Clean per SDS requirements but generally most spills can be cleaned up according to the following:
      - Absorb liquid spills with spill kit absorbent material, sand or dirt until liquid is sufficiently converted to solid material.
      - Remove immediately using dry cleanup methods, e.g. broom and shovel, or vacuum operations.
      - Cleanup with water and detergents may also be necessary depending on the spilled material. However, the waste from this operation must be vacuumed or effectively picked up by dry methods. See Pavement Washing SOP.
      - Repeat process when residue material remains.

4. **DISPOSAL:**
   a) Follow SDS requirements but usually most spills can be disposed per the following b. & c.
   b) Generally, most spills absorbed into solid forms can be disposed to the dumpster and receptacles. Follow Waste Management SOP.
   c) Generally, liquid waste from surface cleansing processes may be disposed to the sanitary sewer system after the following conditions have been met:
      - Dry cleanup methods have been used to remove the bulk of the spill and disposed per the Waste Management SOP.
      - The liquid waste amounts are small and diluted with water. This is intended for spill cleanup waste only and never for the disposal of unused or spent liquids.

5. **Documentation:**
   a) Document all spills on Appendix C forms.

6. **SDS sheets:**
   a) SDS Manual is filed in break room.

7. **Materials:**
   a) Generally, sand or dirt will work for most clean up operations and for containment. However, it is the responsibility of the owner to select the absorbent materials and cleanup methods that are required by the SDS Manuals for chemicals used by the company.

8. **Training:**
   a) Annually and at hiring.

APPENDIX C – PLAN RECORDKEEPING DOCUMENTS

PURPOSE AND RESPONSIBILITY

This Maintenance Report serves to assure management and maintenance of a private storm water system as required by the Clean Water Act and resultant local regulations.

These storm water facilities are designed to manage the collection and distribution/infiltration and the quality of runoff from storm events. Annual reporting with the associated inspection provides for an ongoing awareness of their effectiveness and the general condition of the facilities and their function.

Please respond to the function and condition of the site facilities for each of the following aspects or areas of concern as a measure of its success in meeting its designed pollution protection of storm water. Include visual / photo documentation were feasible.

1. Parking, Sidewalk, impervious Area
Sediment, leaves, debris, spilt fluids or other waste that collects on parking lots and sidewalks will be carried by runoff, increasing the pollution of downstream waters.

Specific Management/Maintenance activities to address this pollution have been: _____
_____
_____
_____
_____
_____

2. Landscaping
Landscaping is often designed to capture and infiltrate storm water as a desired effect of storm water management. However, the fall of leaves along with landscape operations that produce grass clippings, sticks, dirt, mulch, fertilizers, pesticides and other pollutants that are collected in the storm water are a great impairment to that water. The primary pollutants of concern in the Heber Valley include decaying organic material and nitrates which rob water body of dissolved oxygen required to sustain fish life and impair downstream drinking water quality.

Specific Management/Maintenance activities to address this pollution have been: _____
_____
_____
_____
_____
_____

3. Storm Water Conveyance and Storage
Storm drain inlet boxes, pipe, detention ponds, etc. generally have some storm water treatment or pollution prevention as part of their design. The capture of floating trash and also the settling of heavier sediment particles to cleanout points, are a couple of examples.

Specific Management/Maintenance activities (litter retrieval, vactoring, mosquito abatement, illicit discharge detection) to support this cleanup have been: _____

4. Waste Management
Dumpsters and trash receptacles with lids are intended to prevent precipitation exposure minimizing the uptake of trash contaminants into the storm water. Lids will also prevent the lightweight trash migrating in the wind. Waste handling is necessary part of almost all sites and requires diligent attention to not become a source of storm water pollution.

Specific Management/Maintenance activities to address this pollution have been: _____

5. Construction, Mechanical/Utility Systems & Outside Equipment/Storage
Chemicals and oils are a pollution source that may be a part of mechanical and utility systems existing on site. There may also be the occasional construction or repair activity with associated equipment and materials on site which pose a pollution threat if not given proper storm water consideration.

Specific Management/Maintenance activities to address this pollution have been: _____

MAINTENANCE LOG

Date	Facility/Location, Maintenance Performed, Spill Event	Observation Notes, including but not limited to; Inspection results, Observations, System Performance (effectiveness / inefficiencies), Concerns, Necessary Changes, Etc. Include before / after photos where feasible.	Initials

Heber City – Storm Water Design Manual

9/13/2022

Storm Water Design Manual Presentation Overview

Submittals Requirements

Rainfall

Runoff

Conveyance

Storage

Water Quality

Low-Impact Development

Standard Methodologies

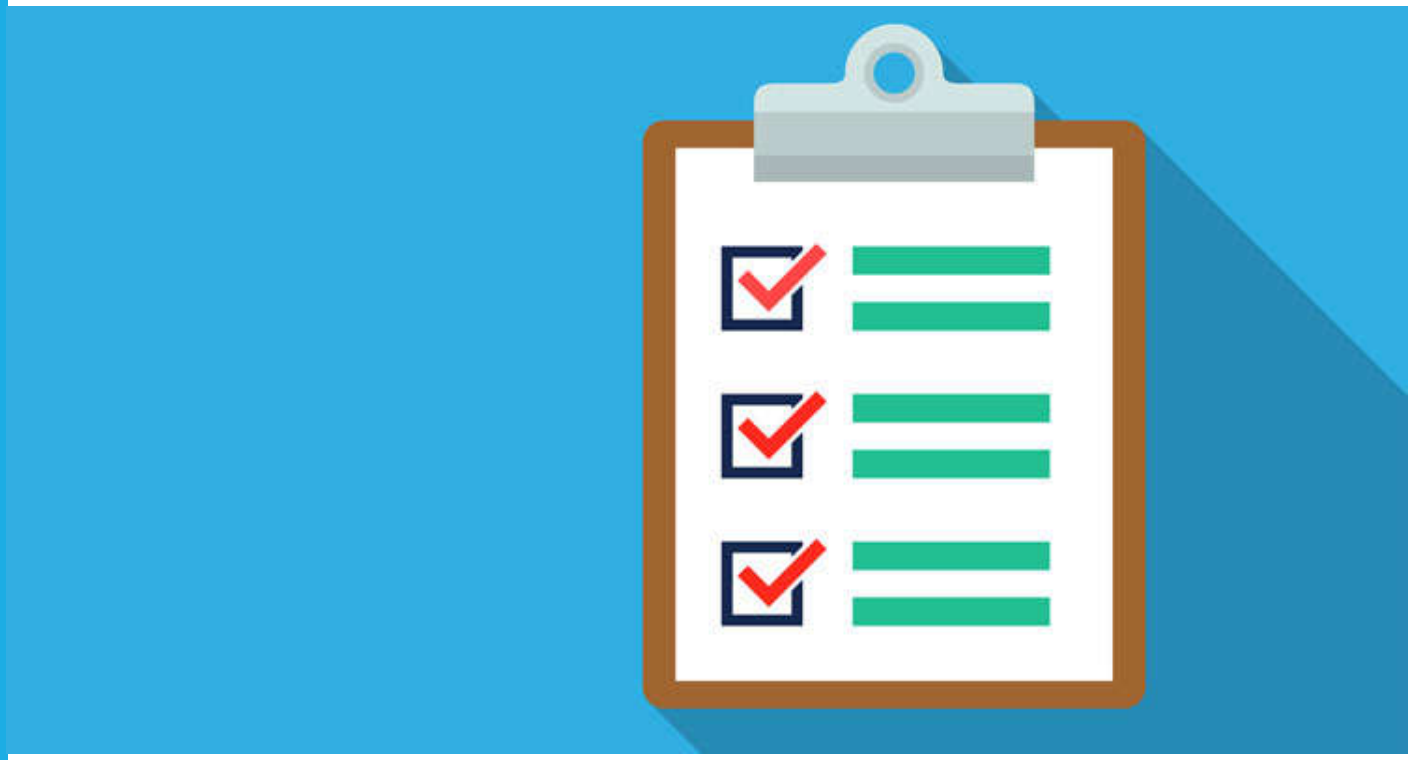
HEBER CITY
HEART OF THE WASATCH BACK

Submittal Requirements

Technical Reports

Engineering Calculations

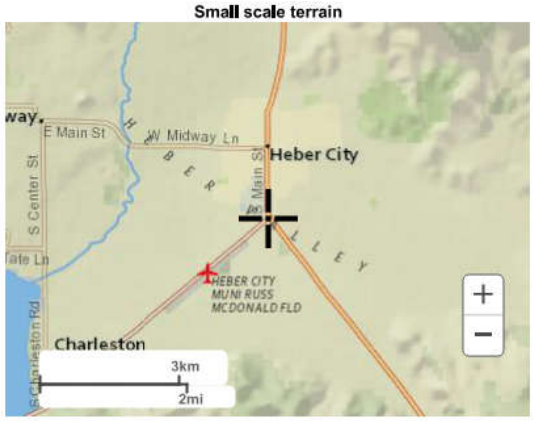
Engineering Drawings

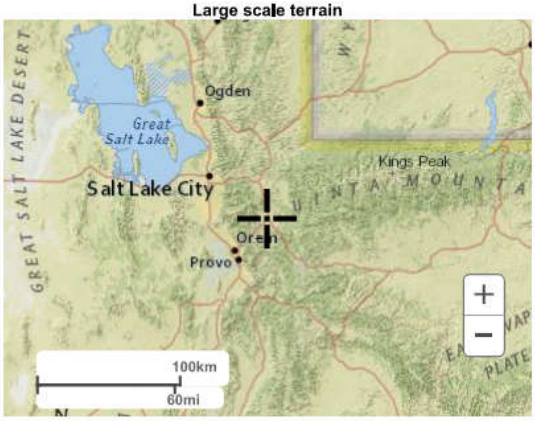


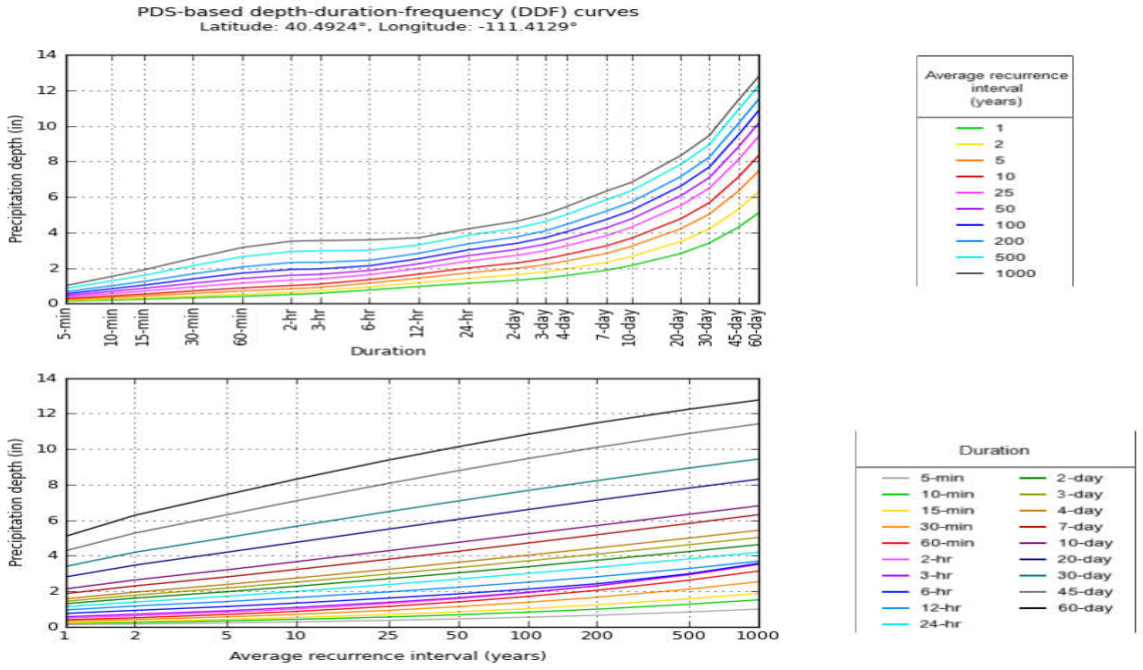
Rainfall

Volume of Rainfall for Return Periods

Temporal Distribution of Rainfall







NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Feb 10 17:47:32 2022

Runoff

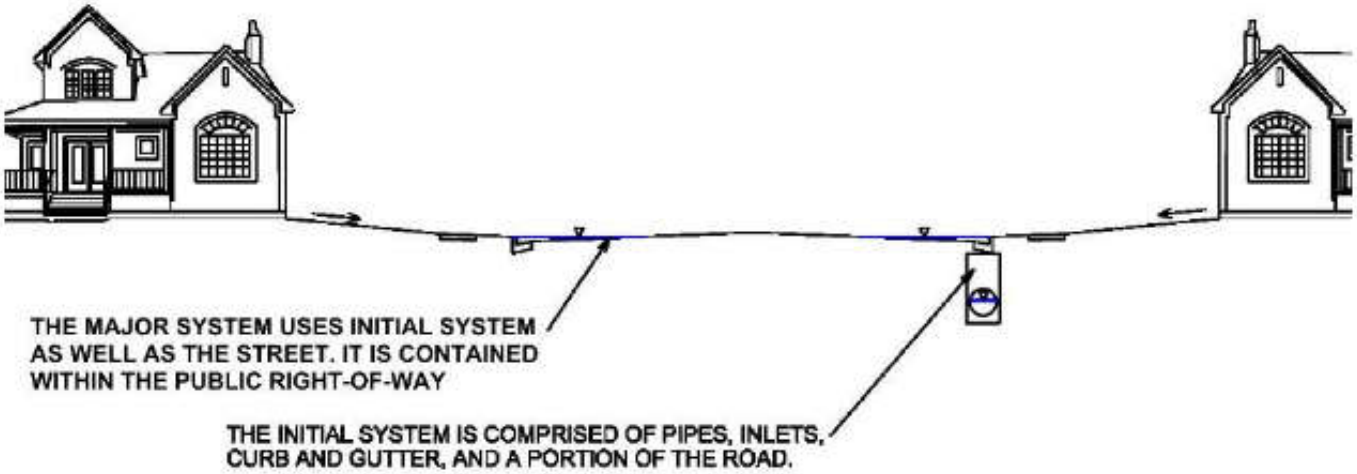
Volume and Flowrates of Runoff for Surface Types



Conveyance

Initial System for Nuisance Flows (piping)

Major System for Floodwaters (surface)



INITIAL AND MAJOR DRAINAGE SYSTEMS

Storage

Detention and Retention



Water Quality

Best Management Practices

Long-Term Storm Water Management Plan

Storm Water Management Agreement



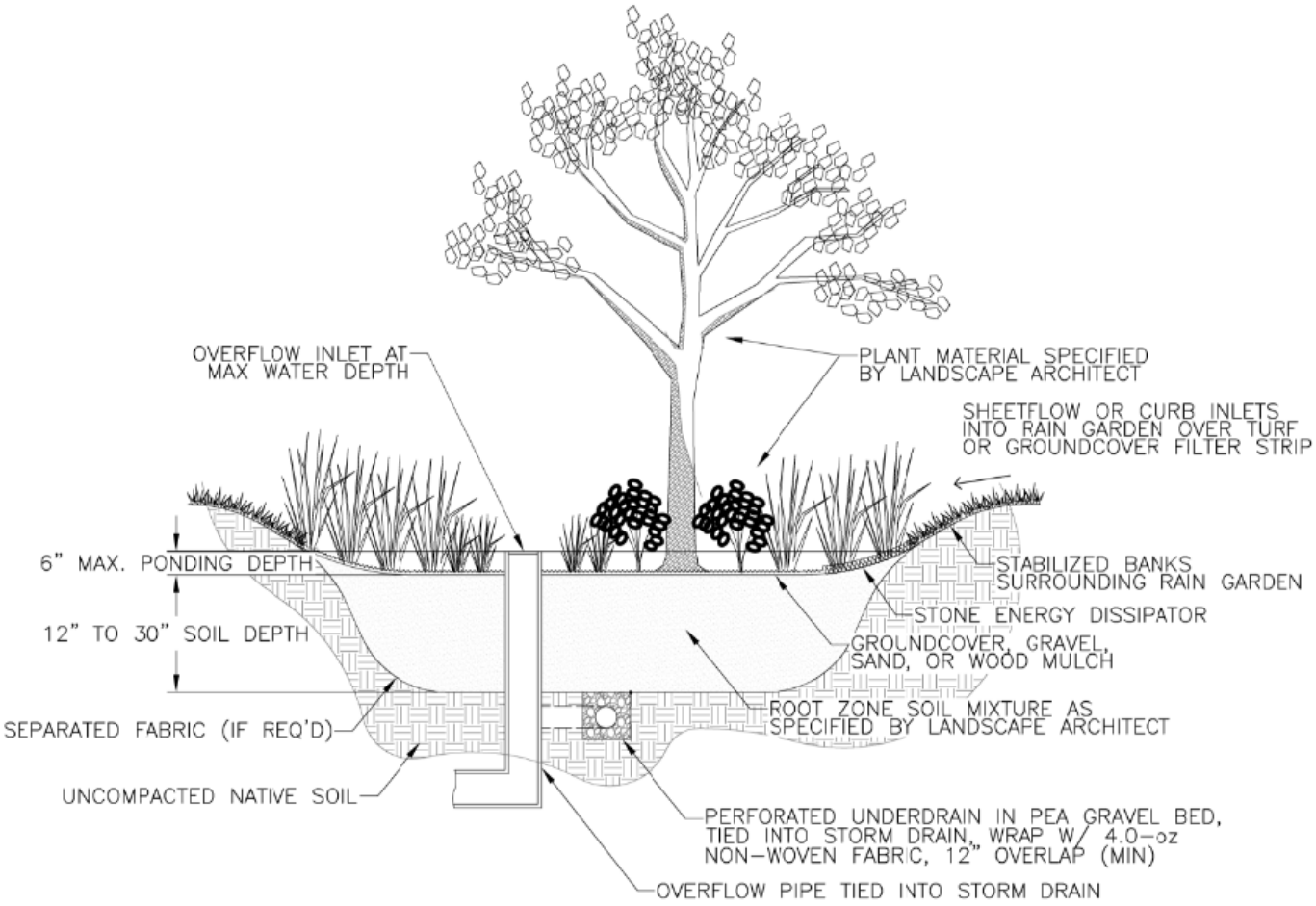
Storm Water Management Agreement

Runs with the Land



Low-Impact Development

An approach to land development, or redevelopment, that works with nature to more closely mimic pre-development hydrologic functions.



Standard Methodologies

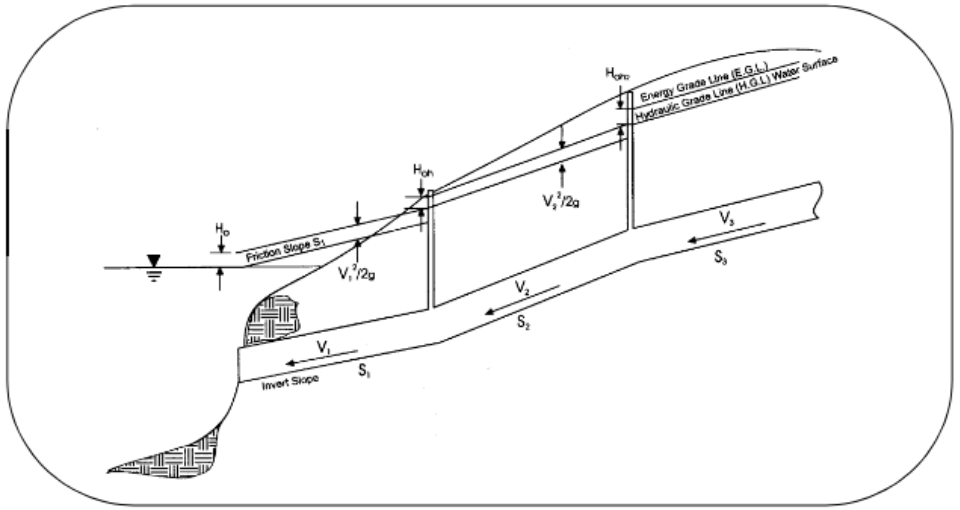
Publication No. FHWA-NHI-01-021
August 2001

U.S. Department
of Transportation

Federal Highway Administration

Hydraulic Engineering Circular No. 22, Second Edition

URBAN DRAINAGE DESIGN MANUAL



Questions or Comments?



Planning Commission Staff Report

MEETING DATE: September 13, 2022
SUBJECT: 2022 North Village Streets and Storm Water Master Plan
RESPONSIBLE: Russell Funk, City Engineer
DEPARTMENT: Engineering **FILE NO:** 20018
STRATEGIC RELEVANCE:
- Principles: Necessary Administrative Action
-Goals: 2) Infrastructure Sustainability

SUMMARY

The purpose of this item is to consider adoption of the North Village Streets and Storm Water Master Plans and Impact Fee Facility Plans as an Amendment to the Heber City Capital Facilities Plan and Heber City General Plan. Staff's intent is to receive input from the Planning Commission and the public, and to seek recommendation for approval by Ordinance to the City Council.

RECOMMENDATION

1. Hold a public hearing and consider public comments on the proposed plan.
2. Consider and recommend approval of the North Village Streets and Storm Water Master Plans and Impact Fee Facility Plans to the City Council for approval by Ordinance.

BACKGROUND

Heber City staff and our consultants have been working to develop this plan for over 2 years. During this time we have met with numerous stakeholders and incorporated much of their input into the proposed plans.

The intent of the plan is to guide development in the North Village area to ensure that the streets and storm water infrastructure planned and built will meet the overall needs of all development planned for the area.

DISCUSSION

The proposed North Village Streets and Storm Water Master Plans and Impact Fee Facility Plan is attached to this Staff Report.

The major components of the report include:

- Population and Growth Projections
- Street System Master Plan including:
    - Details of the Analysis & Modeling Performed
    - A Summary and Exhibits Outlining the Proposed System Improvements
    - Cost Estimates for the Proposed System Improvements
- Storm Water System Master Plan including:
    - Major Concepts

75 N. Main St. ● Heber City, Utah 84032● (435) 654-0757 ● ci.heber.ut.us

        - Separating Developed and Natural Runoff
        - Runoff from Developed areas will be Treated and Retained on-site
        - Large Upstream Retention/Debris Basins for Natural Runoff
        - Detention & Infiltration Basins along Historic Channels for Natural Runoff
        - Restore/Replace Historic Drainage Channels Below the Irrigation Canals.
        - Bypassing of the Irrigation Canals for Natural Runoff
        - Recommended Buffer Zones along Major Natural Drainage Channels
    - Details of the Modeling & Analysis Performed
    - A Summary and Exhibits Outlining the Proposed System Improvements
    - Design Information for System Improvements
    - Cost Estimates for the Proposed System Improvements

FISCAL IMPACT
None

CONCLUSION
N/A

ALTERNATIVES
None

POTENTIAL MOTIONS

Staff Recommended Option - Approval
"I move to forward a positive recommendation of this item as presented to the City Council for Adoption by Ordinance."

Alternative 1 - CONTINUANCE
"I move to Continue this item to ___Date___ , with direction to Staff on information and/or changes needed to render a decision, as follows: …"

Alternative 2 - DENIAL
"I move to Deny this item with the findings described as follows: …"

ACCOUNTABILITY

Department: Engineering
Staff Member: Russell Funk, City Engineer

EXHIBITS / ATTACHMENTS

Proposed North Village Streets and Storm Water Master Plans and Impact Fee Facility Plan

IMPACT FEE FACILITIES PLAN
FOR
STREET SYSTEM AND STORM WATER

NORTH VILLAGE MASTER PLAN 2022 TO 2042

HEBER CITY

HEART OF THE WASATCH BACK

September 8, 2022

Prepared by
Heber City & Horrocks

North Village Master - Plan Table of Contents

Chapter 1 ..... **1-1**

Chapter 2 ..... **2-1**

Chapter 3 ..... **3-1**

Chapter 4 ..... **4-1**

Chapter 5 ..... **5-1**

Appendix 1 ..... **North Village Zone Areas**

Appendix 2 ..... **MAG and U.S. Census Bureau Population Data**

Appendix 3 ..... **North Village Study Area and NVOZ Densities**

Appendix 4 ..... **Vistro Traffic Volumes**

Appendix 5 ..... **ITE Trip Generation**

Appendix 6 ..... **Street System Cost Summary**

Appendix 7 ..... **Storm Water Design Water Manual**

- **Appendix A** ..... **Cross Drainage Flow Rates Summary Map**
- **Appendix B** ..... **IDF Data**
- **Appendix C** ..... **CN List**
- **Appendix D** ..... **Infiltration & Groundwater Maps**
- **Appendix E** ..... **80th Percentile**
- **Appendix F** ..... **LID Details**
- **Appendix G** ..... **TR-55 Worksheets**
- **Appendix H** ..... **Source Protection Maps**
- **Appendix I** ..... **FAA Spreadsheets**
- **Appendix J** ..... **Storm Water Maintenance Agreement and Management Plan**

Appendix 8 ..... **Cross Drainage Flow Rates Summary Map**

Appendix 9 ..... **North Village Percolation Testing Summary**

Appendix 10 ..... **North Village Drainage Area**

Appendix 11 ..... **Storm Water Facility Cost Summary**

Chapter 1

Executive Summary

1.1 Document Purpose and Organization

Heber City is responsible for providing public services to customers within a current area of approximately 5,617 acres in Wasatch County, that does not include North Village and Jordanelle area. The current municipal boundary of Heber City is approximately 13,905 acres, including North Village and the Jordanelle Property area. If all of the North Village area annexes to Heber City the total area of Heber City will be approximately 14,640 acres.

The public services provided by Heber City in North Village and Jordanelle Property areas will be limited to Storm Water and Streets. The Master Plan study area of North Village south of SR 32 and east of US 40 is approximately 1,167 acres. The North Village area including the areas north of SR 32 and east of US 40 is 1,692 acres. The total study area is approximately 3,080 acres including the contributing drainage basins east of North Village. See Appendix 1 for the North Village Zone areas on how this information was obtained.

This document is a compilation of the master plan for North Village area, including the Storm Water and Streets Facilities Plan, and Impact Fee Facilities Plan, hereafter collectively called the "Master Plan". This Master Plan document combines these elements into one comprehensive study. The impact fee analysis for North Village will be prepared in a separate study.

The annexation of North Village into Heber City has created the need to prepare this Master Plan. The City adopted the North Village Overlay Zone NVOZ into their Municipal Code in March 2021 to help facilitate and direct the development in North Village. The NVOZ document includes a General Master Plan Zoning Map, which was also utilized to prepare this Master Plan.

North Village currently has very little public infrastructure and is currently ~95% open land. To adequately service the projected growth and development in North Village, new public facilities for North Village are needed. The new streets and storm drainage systems were planned for and are reported in this document and are the capital improvements necessary to allow for this growth in order to meet the demands of the projected development in North Village through the year 2042, while maintaining the current City Level of Service (LOS) for those facilities. This document also provides associated improvement costs for the capital improvements.

Service Area

This Master Plan was prepared for North Village area south of SR 32. Most of the area has not yet annexed into Heber City, but remains in Wasatch County unincorporated, although most of the area is anticipated to eventually annex into the City. This Master Plan should not only apply

DRAFT

to areas of North Village that are annexed into Heber City but also the areas that remain in Wasatch County. It is recommended that Heber City coordinate with Wasatch County to pursue a Memorandum of Understanding regarding enforcement of the requirements of this Master Plan regardless of whether properties in the North Village area annex into Heber City or develop in Wasatch County.

Organization of the Master Plan Document

The first three chapters of this document outline the purpose of this Master Plan, provide a basis for the impact fee facilities plan, and anticipated population growth for Heber City and North Village. These chapters yield the general foundation for this report which is necessary to analyze each facility through a 20-year planning period.

North Village streets and storm drain systems were analyzed through a 20-year planning period. Chapters 4 and 5 document the findings of the analysis for each facility, respectively. A separate appendix contains the additional data and material supporting this document.

1.2 Summary of Capital Improvement Costs

Recommended capital improvements were analyzed and are provided in their respective chapters. These improvements are necessary to maintain the current Level of Service (LOS) in North Village during future growth and development. The capital improvements recommended in this study are not used to improve LOS to Heber City residents or North Village with respect to streets or storm water. Any projects which may improve existing LOS would be paid for by operating funds.

Estimated costs of the recommended improvements are summarized in Table 1-1 by facility type. The improvement costs are in 2022 dollars and are the costs for all public facilities during the 20-year planning period. Contingencies, engineering, legal and administrative fees are also included. It is anticipated that these improvements be funded through Impact Fees or Public Improvement Districts. Developer contributions, City operating funds, and other funds such as grants or other public entity funds are other potential sources.

Table 1-1 Estimated Cost of Recommended Improvements

Facility	Estimated Cost of Recommended Improvements (2022 dollars)
Streets	$104,472,798
Storm Drain	$22,234,086
TOTAL	**$126,706,884**

All public facilities projected through the 20-year planning period were determined based on the need created by both future residential and non-residential growth. The cost of each facility was determined from sound estimating procedures using historic construction cost records for each particular facility, current land acquisition costs, typical engineering costs, and normal

DRAFT

construction contingencies. Each individual project was analyzed to determine if the costs should be funded by impact fees and then the total costs were summarized. These cost distributions and totals can be found in each chapter in the estimated improvement cost section. Since Heber City has just recently annexed North Village, and the majority of the area is open land, there are no known facilities with excess capacity, therefore any costs for any excess capacity in existing facilities have not been included in the cost totals of this study.

Utility and Impact Fees

Utility fees were not analyzed in this study. It is recommended that the existing storm drain utility fee in Heber City also apply to residents in North Village.

The impact fee analysis will be completed with a separate study.

DRAFT

Chapter 2

Impact Fee Facility Plan Summary

2.1 Information for Future Fee Analysis

This Master Plan report does not expressly include the impact fee analysis. The impact fee analysis will be completed in a separate report. However, it is anticipated that the information presented in this document, including the impact fee facilities plan, will be used to help prepare the impact fee analysis. In preparation for the impact fee analysis, this report includes information to help facilitate the impact fee analysis that will be a companion document to this Master Plan.

An impact fee is a one-time charge with the purpose of raising revenue for new or expanded public facilities necessitated by development. Impact fees are imposed as a condition of receiving development approval. Under the Impact Fee Act, such facilities must have a useful life of ten years or more. They must also be owned or operated by or on behalf of a local government, special service district, or qualifying private entity. An impact fee, is expressly distinguished from a tax, a special assessment under the special improvement or special district acts, a building permit fee, a hook-up fee, a fee for project improvements, or other reasonable permit or application fees, such as conditional use or subdivision application fees (The Utah Land Use Institute, April 2014, *Utah Impact Fee Handbook and Checklists*).

Impact fees cannot be used to correct existing public facility deficiencies or for routine maintenance activities. The premise behind impact fees is based on the critical assumption that if no development were allowed, the existing facilities would adequately serve the existing level of development within the City. Therefore, the recommended streets and storm drain improvements, outlined in chapters 4 and 5, represent improvements needed to accommodate new growth and to maintain the existing Level of Service (LOS) for these facilities within the North Village.

2.2 Proportionate Share

Impact fees are a form of development exaction. An exaction is generally a fee, in-kind requirement, or dedication of land imposed on development to offset the burdens created by that development on municipal services. Exactions provide only a secondary benefit to existing residents. Much has been written about U.S. Supreme Court decisions, such as Dolan v. Tigard (1994) 114 S.ct.2309, and Utah Supreme Court decisions, such as B.A.M Development v. Salt Lake County, 2008 UT 74, 196 P.3d 601 (Utah 2008) and how they mandate the balancing of burdens created by and imposed upon development. The impact fee seeks to do this. (The Utah Land Use Institute, 2014, *Utah Impact Fee Handbook and Checklists*).

DRAFT

Impact fees should be proportionate and relate to the capital facility service demands of development. The Impact Fees Act includes seven evaluation factors set forth by the Utah Supreme Court decision known as Banberry Development Corp. vs. South Jordan City. These seven factors should be incorporated into the impact fee analysis.

2.3 Future Impact Fee Facilities and Utility Fee

Street System

See Chapter 4 for the Street System Master Plan. Figure 1 in Chapter 4 shows the Street System Plan for North Village and the Impact Fee Facilities recommended for North Village. Future streets are those that should be constructed to meet the needs of the projected ultimate population and future traffic growth. New future streets will generally be constructed by developers, and existing streets that need to be improved will be constructed by a combination of Heber City, UDOT, developers and other potential stakeholders.

Storm Water

See Chapter 5 for the Storm Water Master Plan. Required Impact Fee Facilities for storm water control are solely for undeveloped flow and will all be within or near existing natural drainage channels. All developments within North Village are required to retain storm water on site and follow the guidelines presented the Heber City Storm Water Design Manual. Storm Water Impact Fee Facilities include the following:

- Debris/retention basins upstream of developments
- Culverts under both the Timpanogos and Wasatch irrigation canals at each of the seven existing natural drainage channels
- Intermediate retention and infiltration areas within the natural drainage channels to maintain current infiltration of stormwater runoff
- A final retention basin at the bottom of the drainage on the east side of US 40 to capture any remaining storm water runoff that has not been infiltrated upstream

Utility Fees

Utility fees are monthly fees Heber City uses to generate sufficient revenue to fund respective operating expenses for various facilities. Operating expenses include the monies used for personnel and contractual services, materials, supplies, depreciation, maintenance, and other miscellaneous expenses, and the existing population should fund operating expenses. The scope of this study does not include the review, analysis, or revisions to existing utility fees. All other City fees such as taxes, hookup fees, or other fees are also not covered in this study. New users in North Village will be subject to the existing Heber City storm drain utility fee. See Chapter 5 for more detailed information on this fee.

DRAFT

Chapter 3

Projected Population Growth

3.1 Introduction

A pleasant living environment and a high growth rate along the Wasatch Front have caused Heber City to experience a large increase in population over the past recent years. It is anticipated that the growth will be concentrated in North Village area. To continue providing adequate service to Heber City, and to maintain the current level of service to the residents of Heber City, the City's facilities must be analyzed and improved to keep up with the demands of this growth. This study looks at the transportation and storm water needs of North Village.

The projected conditions relating to North Village facility needs are based upon a number of assumptions such as present growth rates, economic stimuli, environmental and recreational development, but are largely based on the development currently in the planning phase for this area. However, as these factors change, the projected conditions made in this Master Plan Study will also change. To help minimize the effect of changing conditions, the recommendations made in this Master Plan study will be based upon the projected population within the planning period.

3.2 Methodology for Determining Projected Population

The method for projecting population through the year 2042 for Heber City is based on 2020 U.S. Census Estimates and the projected Heber City growth rate, as determined by the Governor's Office of Planning and Budgeting and Mountainland Association of Governments (MAG). MAG has stated that the population and growth rates listed for Heber City include the entire North Village area south of SR 32. Although the growth rate shown in this study for all of Heber City, which includes the North Village, is based on MAG's future population projections for Heber City, the population growth rates used for North Village are proportionally higher because it was assumed approximately half of the total population growth in Heber City will be in the North Village area. The population projection to year 2042 was also compared to the projected ultimate population for North Village which is based on the current population plus generated population from projected future land development within the North Village area and known annexations. The North Village Overlay Zone (NVOZ) Land Use Map and the development summary from Heber City Planning Department were the basis for this information.

The 2042 projected population based on MAG's growth rate is currently less than half the projected North Village ultimate population based on land use and recent planned development. MAG is currently in the process of updating the population growth projections for Heber City

DRAFT

and North Village due to the large amount of development already planned for North Village to ensure the growth rates for all of Heber City are accurate. Heber City needs to coordinate with MAG to update the growth rates while considering all the developers that are planning to annex and develop in North Village, and which will likely increase once this Master Plan is adopted. The population projections for North Village in this study need to reflect any updates in MAG's projections and recommendations from Heber City staff and Council in the upcoming months.

DRAFT

3.3 Results of Calculation

Figure 3-1 shows graphically the population projection for North Village to year 2042. This method assumes an average growth rate of 8.0 % per year to 2042. The 2022 population was estimated by taking the number of apartments and single-family dwellings in North Village (south of SR 32) and multiplying it by the average estimated number of people per household (3.37) in 2020. This number was then compared to the difference between the U.S. Census Bureau and MAG's population data for Heber City. U.S. Census Bureau's 2020 population for Heber City is 16,856 and does not appear to include the people in the North Village. Whereas MAG's 2020 population for Heber City is 18,250 and does include people in the North Village, south of SR 32, according to MAG. This is a difference of 1,394 people. There has been little growth in this part of North Village since 2020, therefore, 1,394 people was used as the 2022 population for North Village south of SR 32. The effect of homes in North Village that may not be occupied by Heber City residents (e.g. second-homes) has not been considered in this study. See Appendix 2 for population data from MAG and the U.S. Census Bureau.

Figure 3-1

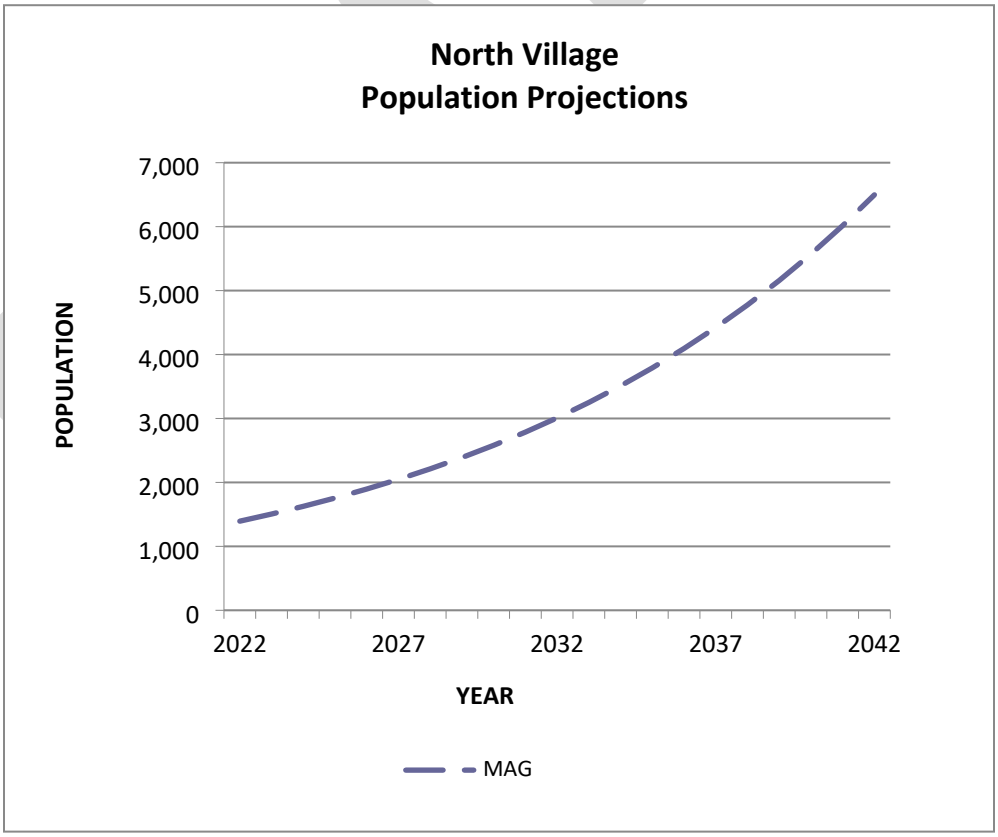


Table 3-1 lists the population growth rates projected through the year 2042. If the population increases faster than projected, the potential revenue generated will need to be monitored to ensure funds are spent within the time prescribed by law. If the population increases slower than projected, the revenue generated may be insufficient and financing alternatives may need to be considered to complete projects. It is recommended that the Master Plan be updated periodically to minimize these types of revenue changes.

Table 3-1 Heber City and North Village Population Projections

HEBER CITY POPULATION PROJECTION														
	HEBER CITY TOTAL (from MAG)				WC UNINCORPORATED (from MAG)			NORTH VILLAGE EST				HEBER CITY w/o NV			GROWTH RATES
YEAR	%CHG	HC POP	CHG POP		% CHG	WC UI POP	CHG	% OF HCT	% CHG	NV POP	CHG	POP TOTAL	CHG		
2020		18,250				7,473		7.64%	0.00%	1,394		16,856	0		MAG Avg Chg/Yr (2021-2030)
2021	2.56%	18,717	467		3.90%	7,764	291	7.45%	0.00%	1,394	0	17,323	467		2.56%
2022	2.56%	19,196	479	946	3.90%	8,067	303	7.26%	0.00%	1,394	0	17,802	479	946	
2023	2.56%	19,688	491		3.90%	8,382	315	7.65%	8.00%	1,506	112	18,182	380		MAG Avg Chg/Yr (2031-2040)
2024	2.56%	20,192	504		3.90%	8,709	327	8.05%	8.00%	1,626	120	18,566	384		1.95%
2025	2.56%	20,709	517	1,021	3.90%	9,048	340	8.48%	8.00%	1,756	130	18,953	387	770	
2026	2.56%	21,239	530		3.90%	9,401	353	8.93%	8.00%	1,897	140	19,342	390		MAG Avg Chg/Yr (2041-2045)
2027	2.56%	21,783	544		3.90%	9,768	367	9.40%	8.00%	2,048	152	19,734	392		1.95%
2028	2.56%	22,340	558		3.90%	10,149	381	9.90%	8.00%	2,212	164	20,128	394		
2029	2.56%	22,912	572		3.90%	10,545	396	10.43%	8.00%	2,389	177	20,523	395		WC UI Ave Chg/Yr (2021-2030)
2030	2.56%	23,499	587	2,260	3.90%	10,956	411	10.98%	8.00%	2,580	191	20,918	395	1,576	3.90%
2031	1.95%	23,957	458		3.45%	11,334	378	11.63%	8.00%	2,787	206	21,170	252		
2032	1.95%	24,424	467		3.45%	11,725	391	12.32%	8.00%	3,010	223	21,414	244		WC UI Ave Chg/Yr (2031-2040)
2033	1.95%	24,900	476		3.45%	12,129	405	13.05%	8.00%	3,250	241	21,650	236		3.45%
2034	1.95%	25,386	486		3.45%	12,548	418	13.83%	8.00%	3,510	260	21,876	226		
2035	1.95%	25,881	495	1,924	3.45%	12,981	433	14.65%	8.00%	3,791	281	22,090	214	919	
2036	1.95%	26,386	505		3.45%	13,429	448	15.52%	8.00%	4,094	303	22,291	201		
2037	1.95%	26,900	515		3.45%	13,892	463	16.44%	8.00%	4,422	328	22,478	187		
2038	1.95%	27,425	525		3.45%	14,371	479	17.41%	8.00%	4,776	354	22,649	171		
2039	1.95%	27,959	535		3.45%	14,867	496	18.45%	8.00%	5,158	382	22,802	153		
2040	1.95%	28,505	545	2,119	3.45%	15,380	513	19.54%	8.00%	5,570	413	22,934	133	643	
2041	1.95%	29,060	556		0.60%	15,472	92	20.70%	8.00%	6,016	446	23,044	110		
2042	1.95%	29,627	567		0.60%	15,565	93	21.93%	8.00%	6,497	481	23,130	85		
TOTAL CHANGE (2022-2042)			10,431								5,103		5,327		
ESTIMATE 2022			19,196								1,394		17,802		
TOTAL 2042			**29,627**								**6,497**		**23,130**		
ULTIMATE PER LANDUSE											**14964**				

NOTES:
- MAG = Mountainland Associations of Governments

MAG Persons per Household Projections

Year	Persons/HH
2020	3.37
2030	3.06
2040	2.94
Average	3.12

US Cenus Persons Per Household

Year	Persons/HH
2020	3.48

DRAFT

Table 3-2 lists the future developments in North Village. Concept development plans recently proposed to Heber City and the NVOZ ordinance were both considered. The table calculates the new residential units and non-residential square footage at full buildout. The ultimate population is estimated by multiplying the total new projected number of residential units by the average number of persons per household (3.12 - average for next 20 years). The existing population is included but also absorbed by this number where the existing homes and properties are proposed to redevelop. Table 3-2 includes the existing and future developments within North Village including those that are north of SR 32. The projected ultimate population also includes North Village areas north of SR 32, although this study is only for North Village area south of SR 32 and east of US 40. See Appendix 3 for additional information on the NVOZ allowed densities.

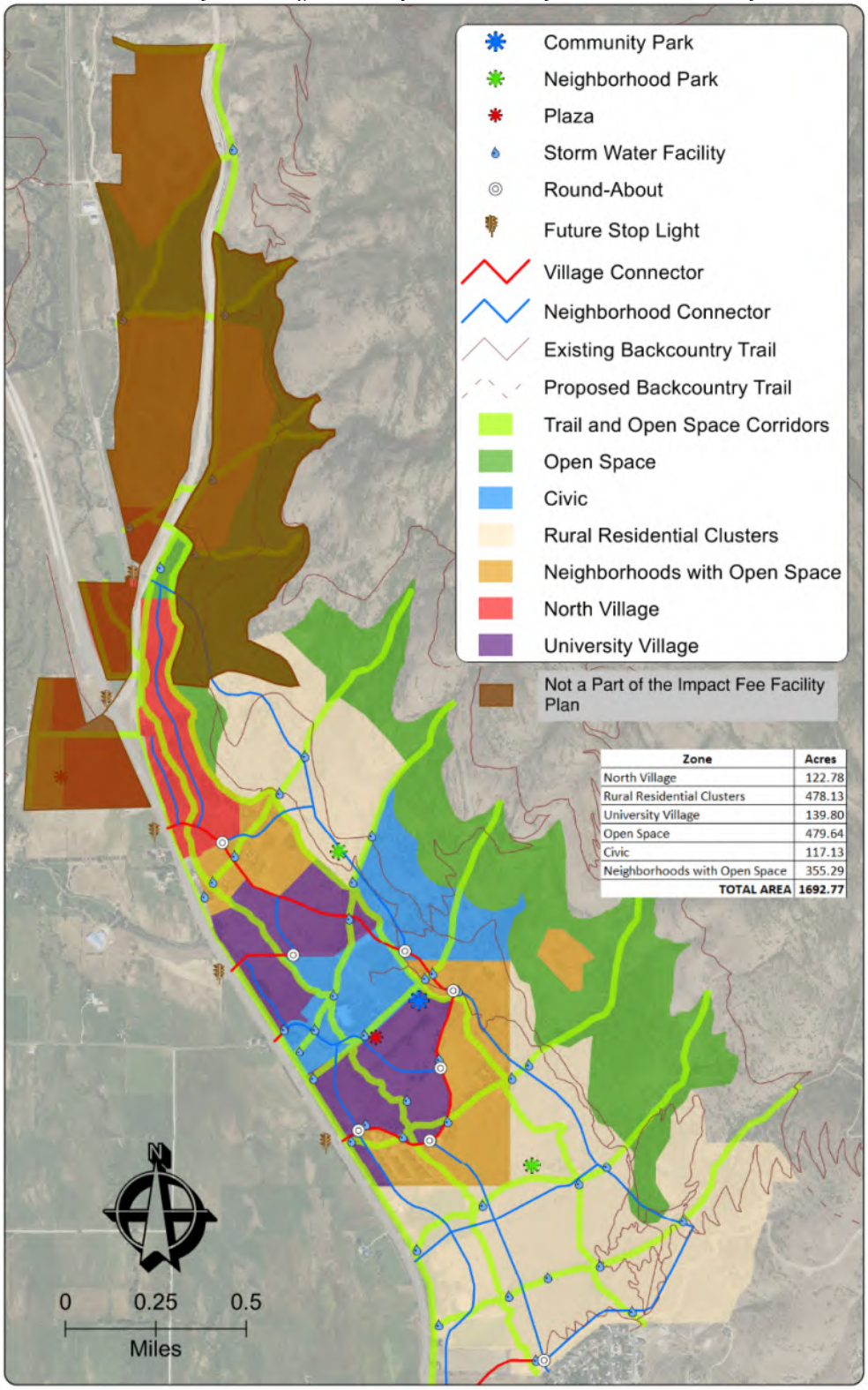
See Table 3-1 above to see how the average person's per household for the next 20 years was calculated. Figure 3-2 below shows the area of North Village that are and are not included in this study.

Table 3-2 Heber City's Developments and Ultimate Population

Development	MP	THs	Apts	SFD	Comm. SF	Industrial SF	Car Wash	Storage	Church	Hotel Rms	Status
Sorenson	85			85							MDA
Sorenson	30			30							MDA
Sorenson	35			35							MDA
Sorenson	70			70							Concept
Sorenson	175			39							Concept
Sorenson	225			225							Concept
Sorenson Civic	0			6							Concept
Sorenson	56			34							Concept
Sorenson	120		120								MDA
Sorenson	130		130								Preliminary/Final
Sorenson	90			83							Preliminary/Final
Sorenson		121		40							Preliminary/Final
Sorenson	30	233									Preliminary/Final
Sorenson	96			45							Preliminary/Final
Sorenson	20			22							Preliminary/Final
Sorenson	140	64		25							Preliminary/Final
Sorenson (High School)											MDA
North Village Resort Residential		37									Annexation Process
Heiner Residential		13									Annexation Process
Jordanelle Ridge Unincorporated		48		83							Unincorporated
Moulton Lane Development Unincorporated				90							Unincorporated
Highlands Residential		76		173					1		MDA
Jordanelle Ridge Plat C				78							Preliminary/Final
Jordanelle Ridge Townhomes Phase B		201									Construction
Highlands Mixed Use		208	664	20	88,000			48,000		80	MDA
North Village Views		180	180								Annexation Process
Finch Creek Townhomes		139			12,040						Annexation Process
Assisted Living					120,000						Annexation Process
Resort Commercial					190,171						Annexation Process
Heiner Commercial					73,000						Annexation Process
North Village Crossings Unincorporated		10	328		39,000		2,500			100	Unincorporated
River Road Existing Homes					72,240						Unincorporated
Baum			144		121,300						Unincorporated
DMJ						125,325					MDA
Fitzgerald		28		111					1		Annexation Process
UVU											Public University
Commons			320								Unincorporated
College Downs		38	220		8000					40	Annexation Process
		1,396	**2,106**	**1,294**	**723,751**	**125,325**	**2,500**	**48,000**	**2**	**220**	
ERU's per unit		0.5	0.75	1							
ERU's		698	1,580	1,294							
Ultimate Population based on 3.12 persons per household		4,356	6,571	4,037							
Population Total (3.12 per household)		**14,964**									
Dwelling Unit Total		**4,796**									
Non-Residential SF Total		**899,576**									
Hotel Unit Total		**220**									

Figure 3-2 North Village Community Design Map (3/21)

Note: Road Layout is changed. See Chapter 4 for Street System Master Plan and layout



Zone	Acres
North Village	122.78
Rural Residential Clusters	478.13
University Village	139.80
Open Space	479.64
Civic	117.13
Neighborhoods with Open Space	355.29
TOTAL AREA	1692.77

North Village Community Design Map

Chapter 4

North Village Street System Master Plan

4.1 Summary and Recommendations

Introduction

North Village is approximately 1,693 acres in size. There are currently no major road networks in the area. The recommended future street system for North Village contains five road classifications: Minor Local, Major Local, Minor Collector, Major Collector, and Minor Arterial. At a minimum, developers are required to provide Minor or Major Local streets within their developments consistent with Heber City's Streets Master Plan. Traffic generated by the development itself may facilitate the need for streets larger than local streets. Developers are required to provide the street classification necessary to accommodate the development.

Residents in the Wasatch County and other areas outside of North Village also impact the street system. Future planned development areas, Heber City's Transportation General Plan, and the North Village Overlay Zone Plan have been used to determine the recommendations for future street improvements. The traffic model data used was based on full build-out in North Village.

North Village design criteria used in this study are summarized below:

- Road Width:
  - Minor Local — ROW 56 feet — Asphalt 26 feet
  - Major Local — ROW 62 feet — Asphalt 32 feet
  - Minor Collector — ROW 68 feet — Asphalt 38 feet
  - Major Collector — ROW ≥ 80 feet — Asphalt 50* feet
  - Minor Arterial — ROW ≥ 90 feet — Asphalt 60 feet

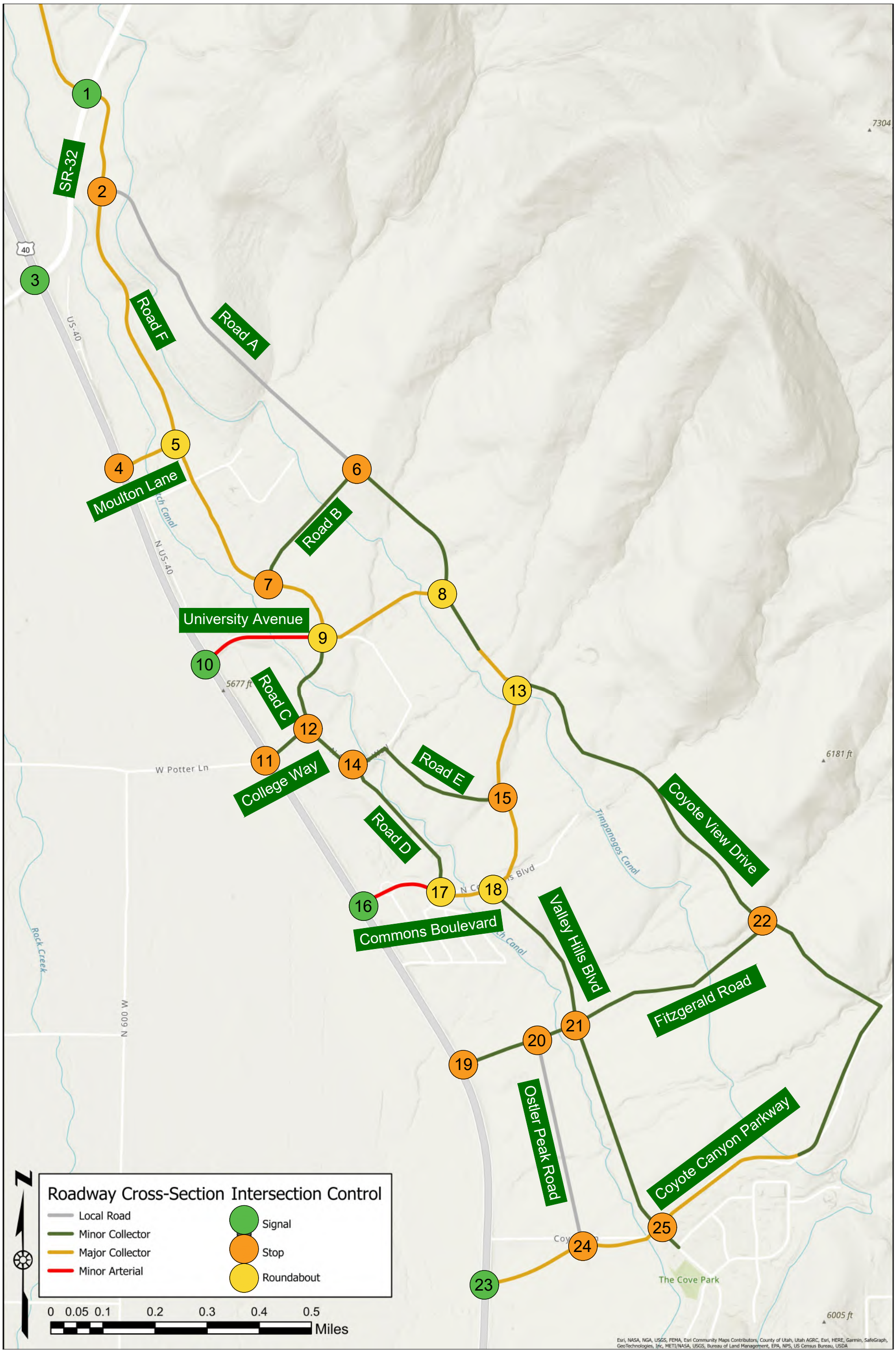
* See Heber City Standard Drawing Cross Section

- Trip Generation:
  - Single Family — 9.43 Average Trips/Unit
  - Townhomes — 7.20 Average Trips/Unit
  - Multi-family — 6.74 Average Trips/Unit
  - Non-Residential / Commercial — 14.96 Average Trips/ksf

Street System Plan

Figure 4-1 shows the Street System Plan for Heber North Village. The existing and future streets shown in the Master Plan reflect the major network of streets, transportation needs, and recommended Impact Fee Facilities for North Village. Future streets are those that should be

DRAFT



Horrocks.
2162 WEST GROVE PARKWAY
SUITE #100
PLEASANT GROVE, UT. 84062
(801) 763-5100

Overview Map
Heber North Village

FIGURE 4-1

SCALE:
N/A

DATE:
9/2022

constructed to meet the needs of the projected population and traffic growth. New future streets will generally be constructed by developers, and existing streets that need to be improved will be constructed by a combination of Heber City, UDOT, developers and other potential stakeholders. Existing streets include US 40, SR-32, Old Highway 40, Commons Boulevard, College Way, Coyote Canyon Parkway, and Valley Hills Boulevard connecting to the south.

Development Standards

Heber City's streets comprise five typical street classifications: Minor Local, Major Local, Minor Collector, Major Collector, and Minor Arterial. The Master Plan designates each existing and future major street as one of these classifications. A description of the widths and typical costs of the respective streets are shown in **Table 4-1**. Developers are required to construct Minor and/or Major Local streets depending on input from Heber City Planning and Engineering, unless the Street Master Plan recommends a larger street to be constructed. The developer may be reimbursed from impact fees for the upgraded street costs depending on the street classification needed for the development itself. Cross-sections for the larger collector and arterial streets are discussed in section 4.1.1 Roadways.

Table 4-1: Heber City's Portion of Cost and Street Size Requirements

Classification	Right-of-Way Width (ft)	Paved Width (ft)	Cost Increase from Major Local ($/LF)
Minor Local	56	26	N/A
Major Local	62	32	N/A
Minor Collector	68	38	$24.52
Major Collector	85	50**	$42.91
Minor Arterial	95	60	$73.56

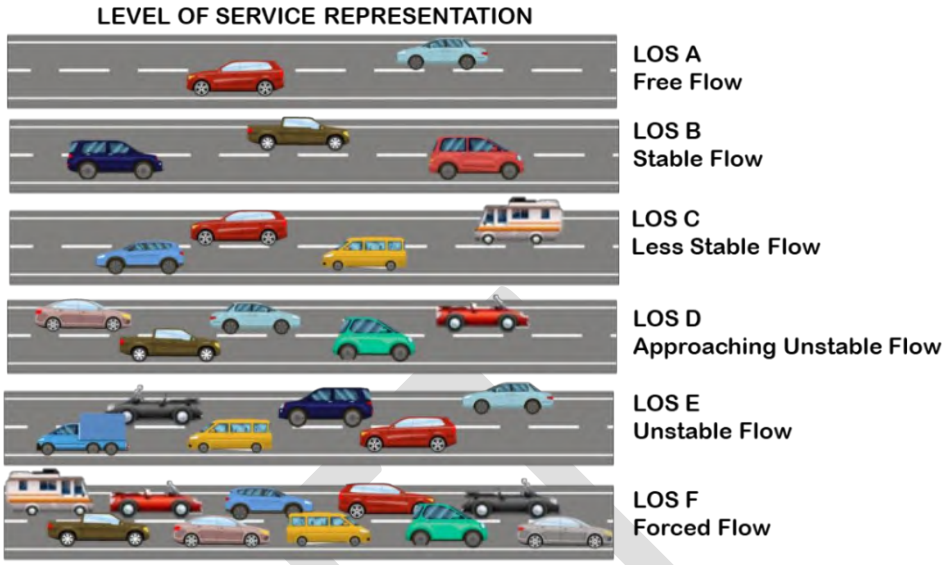
* If pavement width varies cost per lineal foot is $3.06/LF
** See Heber City Standard Drawing Cross Section

Level of Service

Street systems offer a wide range of choices in terms of services provided. The characteristics of streets are often evaluated in terms of travel time, frequency, comfort, reliability, convenience, and safety. The term level of service (LOS) is used to describe these attributes.

The current standard for LOS on Heber City streets is a LOS of C or better. At LOS C, stable operation is provided, but flows approach the range at which an increase in volume immediately results in a deterioration of service. **Figure 4-2** shows a visual representation of LOS A through F.

Figure 4-2: Level of Service



4.1.1 Roadways

Introduction

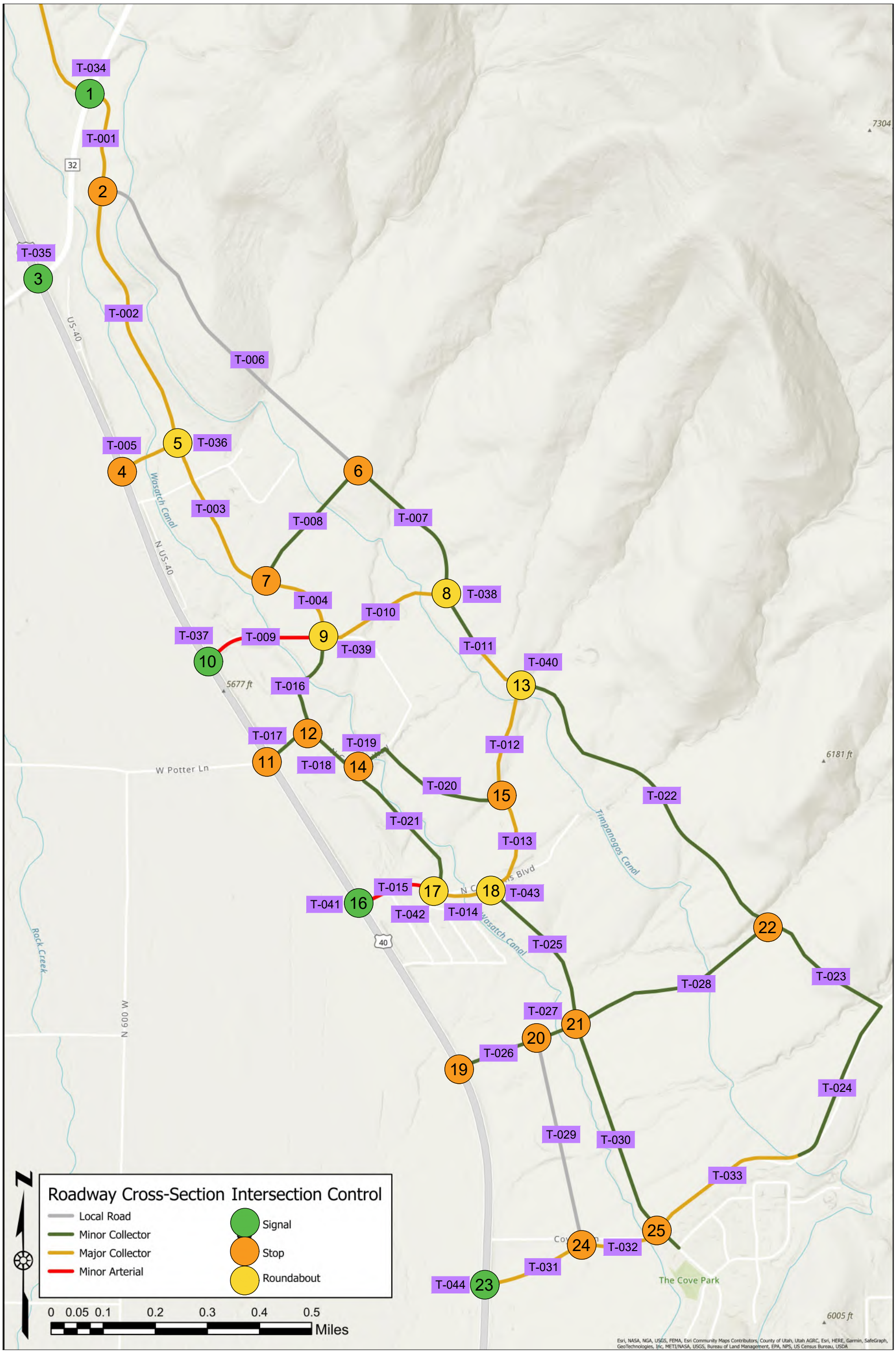
North Village is growing, and the roadway system is designed to facilitate this growth. The roadways are sized according to the developments planned in the immediate vicinity and for the traffic that will utilize the new and improved roadways. There are few existing roadways, and they will be improved or extended to meet the transportation needs of the new projects.

Recommended Street Impact Fee Facilities (Improvements/Extensions)

The street system Impact Fee Facilities recommended to meet the projected population are shown in **Figure 4-3**. These recommendations were determined by projecting the future areas of development, reviewing the adopted Heber City Transportation General Plan, analyzing traffic count data, and incorporating input from City Officials. A detailed listing of the recommended improvements is given in the following paragraphs. Roadway type names differ from the typical roadway classifications, and it is the intent to build typical cross sections throughout the development.

This Master Plan has been adjusted from the original road network shown in Heber City's North Village Overlay Zone plan. These adjustments reflect the need to accommodate higher or lower traffic volumes projected by traffic modeling done for this study. Where traffic modeling did not justify Minor Collectors (Neighborhood Connectors) they were modified to Local (Residential) roadways. Likewise, Major Collectors (Village Connectors) were modified to be Minor Arterials due to the higher volumes of traffic directed to the signalized intersections entering North Village from US 40.

DRAFT



Horrocks.
2162 WEST GROVE PARKWAY
SUITE #100
PLEASANT GROVE, UT. 84062
(801) 763-5100

Roadway & Intersection Project Locations
Heber North Village

FIGURE 4-3

SCALE:
N/A

DATE:
9/2022

Local Street Improvements

T-006 Road A: Road A does not currently exist. It will be approximately 1,700 feet long and should be constructed as a Major Local street between SR 32 and Road B. This project also includes a bridge across the Timpanogos Canal. Topography may make it infeasible to construct this road. If built, it will be 100% developer funded.

T-029 Ostler Peak Road: Approximately 500 feet of the overall 2,200 feet of Ostler Peak Road currently exists on the southern end. It should be constructed as a Major Local between Fitzgerald Road and Coyote Canyon Parkway. It will be 100% developer funded.

Minor Collector Street Improvements

T-007 Road A: Road A does not currently exist. It will be approximately 1,700 feet long and should be constructed as a Minor Collector between Road B and University Avenue.

T-008 Road B: Road B does not currently exist. It will be approximately 1,500 feet long and should be constructed as a Minor Collector between Road F and Road A.

T-016 Road C: Road C does not currently exist. It will be approximately 1,000 feet long and should be constructed as a Minor Collector between University Avenue and College Way. This project includes a bridge across the Wasatch Canal.

T-017 College Way: This section of Collage Way currently exists. It will be approximately 500 feet long and should be reconstructed as a Minor Collector between US 40 and Road C.

T-018 Collage Way: This section of Collage Way currently exists. It will be approximately 700 feet long and should be constructed as a Minor Collector Road C and Road D.

T-019 Collage Way: This section of Collage Way currently exists. It will be approximately 400 feet long and should be constructed as a Minor Collector between Road D and to the UVU south property line. This project includes a bridge across the Wasatch Canal.

T-020 Road E: Road E does not currently exist. It will be approximately 1,400 feet long and should be constructed as a Minor Collector between the UVU south property line and Commons Boulevard.

T-021 Road D: Road D does not currently exist. It will be approximately 1,600 feet long and should be constructed as a Minor Collector between Collage Way and Commons Boulevard.

DRAFT

T-022 Coyote View Drive: This section of Coyote View Drive does not currently exist. It will be approximately 3,800 feet long and should be constructed as a Minor Collector between Commons Boulevard and Fitzgerald Road.

T-023 Coyote View Drive: This section of Coyote View Drive does not currently exist. It will be approximately 1,700 feet long and should be constructed as a Minor Collector between Fitzgerald Road and Coyote Canyon Parkway.

T-024 Coyote View Drive: This section of Coyote View Drive does not currently exist. It will be approximately 1,800 feet long and should be constructed as a Minor Collector between Coyote View Drive and the Timpanogos Canal to the south.

T-025 Valley Hills Boulevard: This section of Valley Hills Boulevard does not currently exist. It will be approximately 1,800 feet long and should be constructed as a Minor Collector between Commons Boulevard and Fitzgerald Road.

T-026 Fitzgerald Road: This section of Fitzgerald Road does not currently exist. It will be approximately 800 feet long and should be constructed as a Minor Collector between US 40 and Ostler Peak Road.

T-027 Fitzgerald Road: This section of Fitzgerald Road does not currently exist. It will be approximately 500 feet long and should be constructed as a Minor Collector between Ostler Peak Road and Valley Hills Boulevard. This project includes a bridge across the Wasatch Canal.

T-028 Fitzgerald Road: This section of Fitzgerald Road does not currently exist. It will be approximately 2,300 feet long and should be constructed as a Minor Collector between Valley Hills Boulevard and Coyote View Drive. This project includes a bridge across the Timpanogos Canal.

T-030 Valley Hills Boulevard: This section of Valley Hills Boulevard does not currently exist. It will be approximately 2,300 feet long and should be constructed as a Minor Collector between Fitzgerald Road and Coyote Canyon Parkway.

Major Collector Street Improvements

T-001 Road F: This section of Road F does not currently exist; it will be approximately 1,200 feet long and should be constructed as a Major Collector between SR 32 and Road A.

T-002 Road F: This section of Road F does not currently exist. It will be approximately 2,800 feet long and should be constructed as a Major Collector between Road A and Moulton Lane.

T-003 Road F: This section of Road F does not currently exist. It will be approximately 1,800 feet long and should be constructed as a Major Collector between Moulton Lane

DRAFT

and Road B.

T-004 Road F: This section of Road F does not currently exist. It will be approximately 1,800 feet long and should be constructed as a Major Collector between Road B and University Avenue.

T-005 Moulton Lane: Moulton Lane will be shifted north of its current location. It will be approximately 600 feet long and should be constructed as a Major Collector between US 40 and Road F.

T-010 University Avenue: This section of University Avenue does not currently exist. It will be approximately 1,400 feet long and should be constructed as a Major Collector between Road F and Road A. This project includes a bridge across the Timpanogos Canal.

T-011 University Avenue: This section of University Avenue does not currently exist. It will be approximately 1,300 feet long and should be constructed as a Major Collector between Road A and Commons Boulevard.

T-012 Commons Boulevard: This section of Commons Boulevard does not currently exist. It will be approximately 1,200 feet long and should be constructed as a Major Collector between University Avenue and Road E.

T-013 Commons Boulevard: This section of Commons Boulevard does not currently exist. It will be approximately 1,100 feet long and should be constructed as a Major Collector between Road E and Valley Hills Boulevard.

T-014 Commons Boulevard: This section of Commons Boulevard does not currently exist. It will be approximately 600 feet long and should be constructed as a Major Collector between Valley Hills Boulevard and Road D. This project includes a bridge across the Wasatch Canal.

T-031 Coyote Canyon Parkway: This section of Coyote Canyon Parkway currently exists. It is approximately 1,100 feet long and is constructed as a Major Collector between US 40 and Ostler Peak Road.

T-032 Coyote Canyon Parkway: This section of Coyote Canyon Parkway currently exists. It is approximately 900 feet long and is constructed as a Major Collector between Ostler Peak Road and Valley Hills Boulevard. This project includes a bridge across the Wasatch Canal.

T-033 Coyote Canyon Parkway: This section of Coyote Canyon Parkway currently exists. It is approximately 1,700 feet long and is constructed as a Major Collector between Valley Hills Boulevard and the Timpanogos Canal. This project includes a bridge across the Timpanogos Canal.

DRAFT

Minor Arterial Street Improvements

T-015 Commons Boulevard: This section of Commons Boulevard currently exists. It will be approximately 800 feet long and should be reconstructed as a Minor Arterial between US 40 and Road D.

T-009 University Avenue: This section of University Avenue is currently a dirt road. It will be approximately 1,200 feet long. It should be reconstructed as a Minor Arterial from US 40 to Road F. This project includes a bridge across the Wasatch Canal.

Other Improvements

T-045 North Village Streets Master Plan Updates: This project will fund updates to the North Village transportation Master Plan every 5 years.

4.1.2 Intersections

Introduction

A variety of factors will affect the traffic and the intersection improvements needed to meet the future growth in North Village. The intersection types used in this study are signalized, two-way stop controlled, and roundabouts. Roundabouts may be a good alternative to stop-controlled intersections as they can be single lane or multiple lanes. Roundabouts allow for a higher volume of vehicles to pass through than a stop-controlled intersection, however they require a larger physical footprint. The basic intersection layouts are shown in the following pages and are not to be used for the final design as they are not construction drawings.

Projected populations were used in conjunction with development plans to determine where the new streets should be constructed based on the planned and potential areas of development. **Figure 4-3** shows the intersection locations and type of control i.e., traffic signal, roundabout, stop sign.

Signalized Intersections

The intersections that are signal controlled are generally higher volume roadways. A traffic signal should not be installed unless it meets warrants for a signal. Even when an intersection meets warrants for a signal, this does not indicate that a signal must be installed. Traffic signals do not always increase the safety of an intersection, and this is an important aspect to consider when evaluating the installation of a new traffic signal. The proposed signalized intersections include SR 32 and Road F, US 40 and University Avenue, US 40 & Commons Boulevard, and US 40 and Coyote Canyon Parkway. There are no proposed signalized intersections within North Village.

DRAFT

Roundabouts

The intersections that have a roundabout installed have a yield control at each approach and vehicles inside the roundabout have priority. The roundabout can have a single lane or multiple lanes and can accommodate large volumes of traffic. There is one existing intersection with a roundabout on Commons Boulevard, which was constructed less than 250 feet from US 40. This existing roundabout needs to be shifted further from Highway 40 as the queue lengths from future traffic will block the intersection and restrict traffic. Roundabouts are an optional intersection improvement and would improve the Level of Service for any intersection that is currently stop-controlled. Intersections that meet warrants for an all-way stop controlled intersection have the greatest improvement to the Level of Service with the installation of a roundabout.
A roundabout is proposed to be constructed on Commons Boulevard where it intersects with Valley Hills Boulevard. University Avenue is proposed to have three additional roundabouts installed, one at the intersection of Road F, one at Road A, and another at Coyote View Drive. Road F will have one roundabout at the intersection with Moulton Lane, and the other mentioned previously at the intersection with University Avenue. Roundabouts may also be installed as traffic calming measures, or to enhance the community, and significantly improve the delay experienced during the off-peak hours over a stop-controlled intersection.

Stop Controlled Intersections

The intersections that are stop controlled may have all approaches stop controlled (an all-way stop), or only two approaches stop controlled (two-way stop). Three leg intersections can be stop controlled on all legs or on the one leg with the least traffic volume. Two-way stop control is typically used when two roads intersect, with the stop control placed on the road having the least traffic volume. Most of the new intersections are two-way stop controlled.

The new developments in North Village create a network of roadways, and new intersections where these roads converge. The new intersections are designed to handle the anticipated traffic volumes based upon the proposed roadway use. **Table 4-2** shows the type of intersection control for each intersection as well as the number of lanes in each approach. **Table 4-3** shows the anticipated volume of vehicles for each intersection separated into each movement for the PM peak hour at full project build-out. These traffic volumes on each movement support the recommendations for the number of lanes for each approach at the intersection.

The Average Daily Traffic (ADT) on a roadway measures the number of vehicle trips that happen on an average day. This metric assists in determining the size of the roadway for an acceptable Level of Service. The projected ADT for the full build-out on North Village roadways is shown in **Table 4-4**.

DRAFT

Table 4-2: Number of Lanes for Intersection Approach

Intersection Number	Intersection Control	Controlled Movement	NB Lane Configuration			SB Lane Configuration			EB Lane Configuration			WB Lane Configuration		
			Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
1	Signalized	All	1	1	1	1	1	1	1	1	1	1	1	1
2	Two-way Stop	W	-	1	1	1	1	-	-	-	-	1	-	1
3	Signalized	All							1	1	1	1	1	1
4	Two-way Stop	W										-	-	1
5	Roundabout	All				-	1	-	-	1	-	-	1	1
6	Two-way Stop	All	1	1	-	-	1	1	-	1	1			
7	Two-way Stop	S	-	1	1	1	1	-	1	-	1			
8	Roundabout	All	-	1	-	-	1	-	-	1	-			
9	Roundabout	All	-	1	-	-	1	-	-	2	-	-	2	-
10	Signalized	All			1	2						2	-	1
11	Two-way Stop	E/W	1		1	1		1	1	1	1	1	1	1
12	Two-way Stop	S	1		1	1		1	1	1	-	1	1	-
13	Roundabout	All		1			1						1	
14	Two-way Stop	W		1	1	1	1	-				1		1
15	Two-way Stop	E	1	1	-	-	1	1	1	-	1			
16	Signalized	All			1	2						2	-	1
17	Roundabout	All	-	1	-	-	1	-	-	2	-	-	2	-
18	Roundabout	All	-	1	-	-	1	-	-	2	-	-	1	-
19	Two-way Stop	W			1	1						1	-	1
20	Two-way Stop	N/S	1	1	1	1	1	1	1	1	1	1	1	1
21	Two-way Stop	E/W	1	1	1	1	1	1	1	1	1	1	1	1
22	Two-way Stop	E	1	1	-	-	1	1	1	-	1			
23	Signalized	All			1	1						1	-	1
24	Two-way Stop	S				1	-	1	1	1		-	1	1
25	Two-way Stop	N/S	1	1	1	1	1	1	1	1	1	1	1	1

Table 4-3: Lane Volumes

Intersection Number	NB Lane Volumes			SB Lane Volumes			EB Lane Volumes			WB Lane Volumes		
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
1	29	69	111	29	102	0	0	10	39	13	5	18
2		28		16	134							9
3			97	111						141	0	13
4			185	121								173
5	65	1			105	108	274		32			
6			4		6					10		3
7	126	0	14	21	105	11	16	0	63	6	0	50
8		18				93	154	33				
9	215	0	0	0	0	174	139	434	183	0	249	0
10			311	446						380		258
11			53	115						14		131
12	94	55	0	0	25	24	55	32	82	0	26	0
13		18				33						
14	82	55			25	55		32			26	
15		140			88							
16			399	342						282		204
17	61					202	278	361	102		223	
18	47					89	129	140	92		88	
19			29	15						4		29
20	8					10	4	36	4		16	
21	11					4	29		7			
22												
23			177	190						106		97
24						62	129	238			141	
25	89					36	61	177			105	

Table 4-4: Average Daily Traffic

Average Daily Traffic		
Roadway Name	ADT	Roadway Type
Road A	2,600	Minor Collector
Road B	1,200	Minor Collector
Road C	6,100	Minor Collector
Road D	8,800	Minor Collector
Road E	4,500	Minor Collector
Fitzgerald Road	2,500	Major Collector
Ostler Peak Road	1,900	Major Local
College Way	4,500	Minor Collector
Commons Blvd 1	13,900	Minor Arterial
Commons Blvd 2	5,200	Major Collector
Coyote Canyon Parkway	9,200	Major Collector
Coyote View Drive	2,700	Minor Collector
Moulton Lane	5,800	Major Collector
Road F	8,600	Major Collector
SR 32	8,800	Minor Arterial
University Ave 1	16,100	Minor Arterial
University Ave 2	5,800	Major Collector
Valley Hills Blvd	2,800	Minor Collector

Intersection Improvements

T-034 Intersection 1: This project will construct a UDOT traffic signal on SR 32 at the intersection of SR 32 and Road F. This is anticipated to be 100% funded by UDOT once the warrant is met.

T-035 Intersection 3: This is an existing UDOT traffic signal on US 40 at the intersection of US 40 and SR 32. Any improvements needed at this intersection are anticipated to be 100% funded by UDOT.

T-036 Roundabout 5: This project will construct a single-lane roundabout at the intersection of Moulton Lane and Road F.

T-037 Intersection 10: This project will construct a UDOT traffic signal on US 40 at the intersection of US 40 and Collage Way. This is anticipated to be 100% funded by UDOT once the warrant is met.

T-038 Roundabout 8: This project will construct a single-lane roundabout at the intersection of University Avenue and Road A. A two way stop at this location may also be an acceptable means of traffic control.

T-039 Roundabout 9: This project will construct a multi-lane roundabout at the intersection of University Avenue, Road F, and Road C.

T-040 Roundabout 13: This project will construct a single-lane roundabout at the intersection of University Avenue, Coyote View Drive, and Commons Boulevard. A two way stop at this location may also be an acceptable means of traffic control.

T-041 Intersection 16: This project will construct a UDOT traffic signal on US 40 at the intersection of US 40 and Commons Boulevard. This is anticipated to be 100% funded by UDOT once the warrant is met.

T-042 Roundabout 17: This project will construct a multi-lane roundabout at the intersection of Commons Boulevard and Road D.

T-043 Roundabout 18: This project will construct a single-lane roundabout at the intersection of Commons Boulevard and Valley Hills Boulevard.

T-044 Intersection 23: This project will construct a UDOT traffic signal on US 40 at the intersection of US 40 and Coyote Canyon Parkway. This is anticipated to be 100% funded by UDOT once the warrant is met.

DRAFT

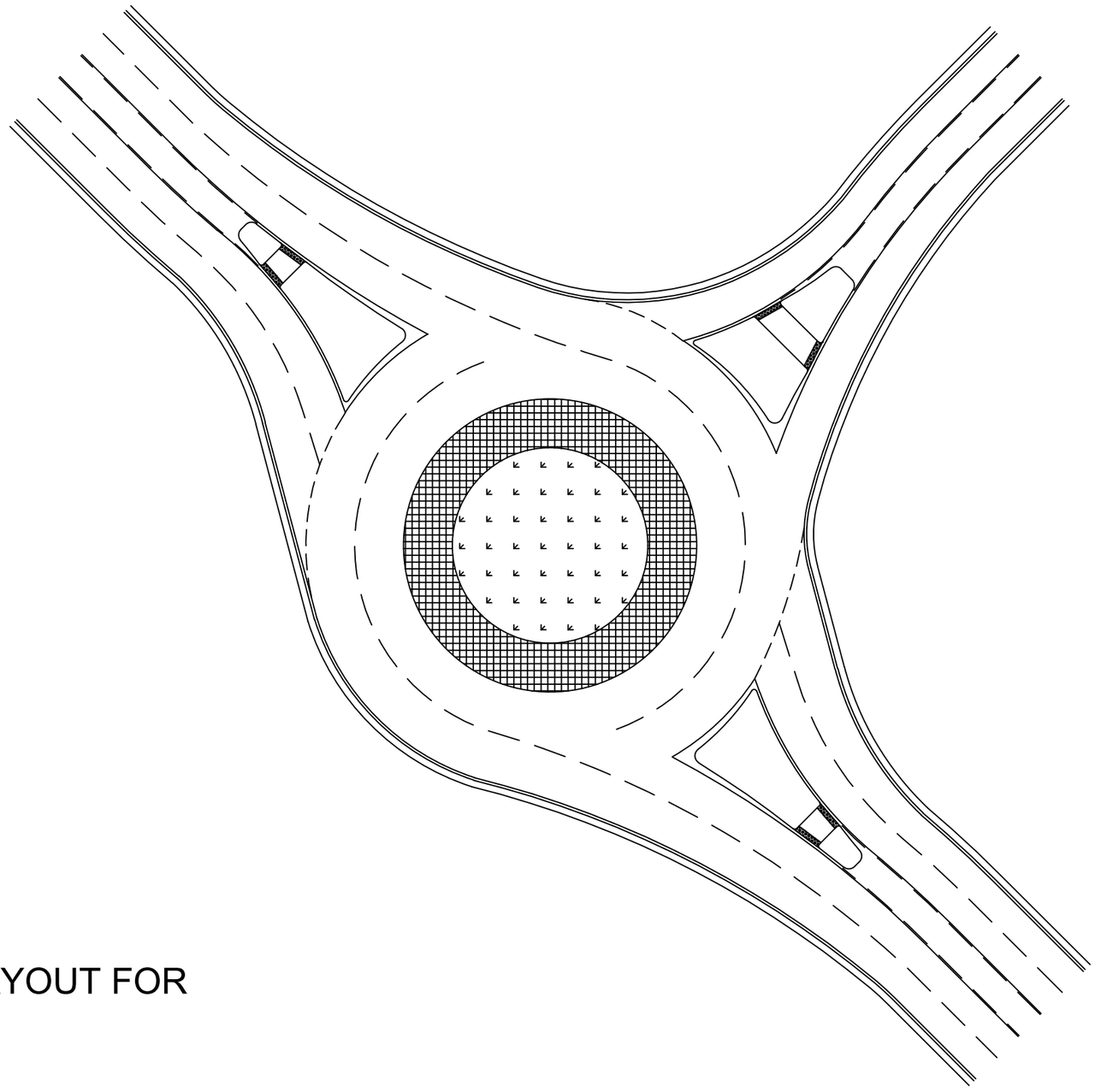
These new intersections should be carefully designed for each physical location as field conditions vary from location to location. There are numerous conditions which could lead to changes in the field and the figures shown in this document are not intended as design or construction documents, merely as concepts for the new intersection layouts.

Figure 4-4 shows the basic concept for a multi-lane roundabout. The multi-lane roundabout has an inscribed diameter of 180 feet and the major roadway (University Avenue) consists of two travel lanes in each direction while the minor roadway has a single lane in each direction. The conceptual design is not to be used for construction and is representative of the design for intersections number 9 and 17. The single lane roundabout shown in **Figure 4-5** has an inscribed diameter of 120 feet and is representative of intersections 5, 8, 13, 18.

Figure 4-6 shows the basic concept for signalized intersections (SR 32 and Road F). All signalized intersections for the project area are on UDOT roadways, and as such are not under the jurisdiction of Heber City.

Figure 4-7 shows the basic concept for a stop-controlled intersection with four legs. Many intersections in this project only have three legs and must be adapted as development occurs. It is possible that developers will design their project access to connect to a three-legged intersection by adding the fourth leg. All construction designs must be approved by Heber City.

DRAFT



THIS IS A GENERAL LAYOUT FOR THE INTERSECTIONS:

9 & 17

*THESE LOCATIONS NEED TO BE CONSIDERED INDIVIDUALLY

PRELIMINARY

NOT FOR CONSTRUCTION

SCALE

HORIZONTAL N/A

VERTICAL N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

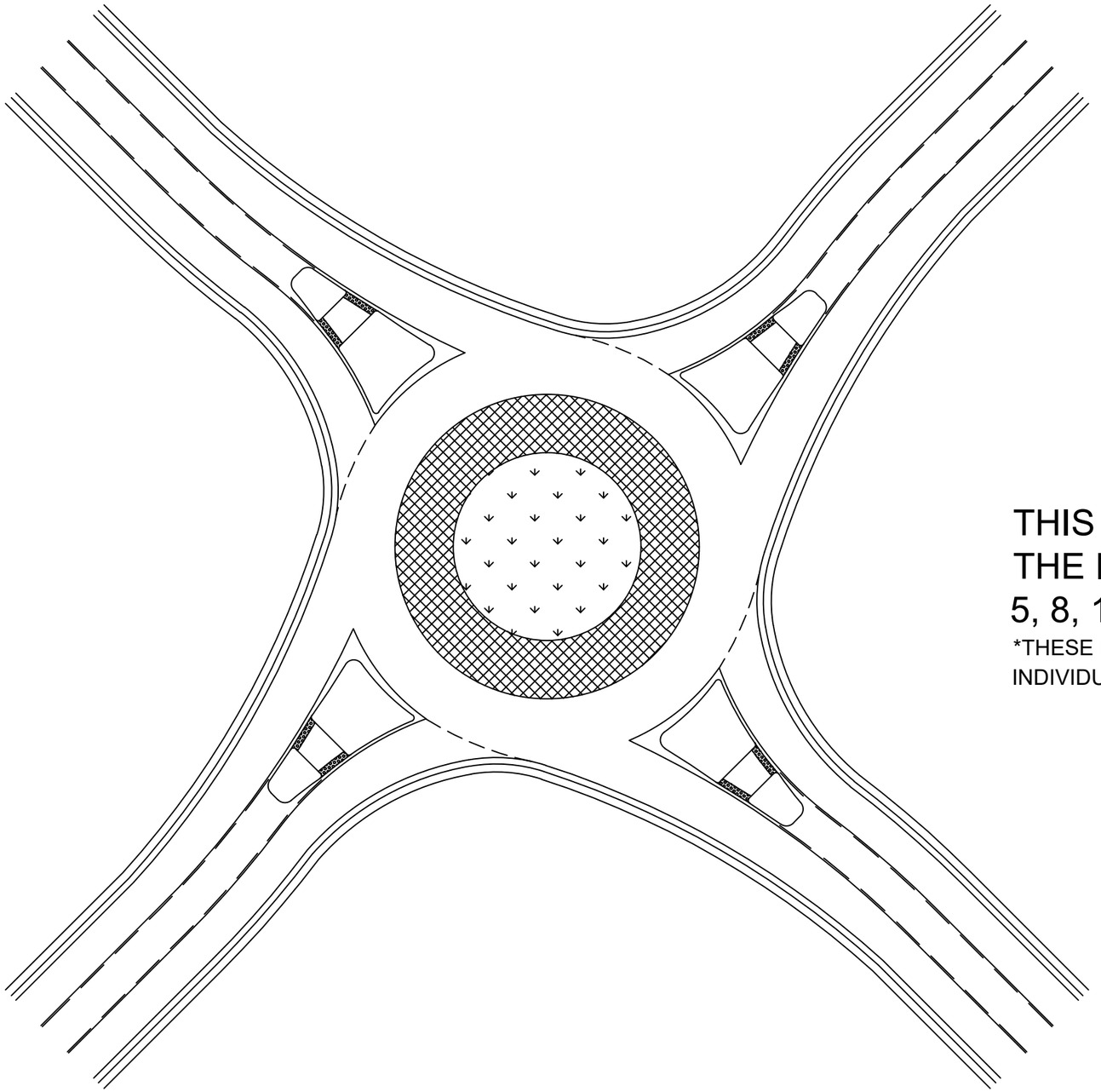
2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

HEBER - NORTH VILLAGE

2-LANE ROUNDABOUT - 180 FT INSCRIBED CIRCLE

DESIGNED	DATE	PROJECT NO.
DRAWN	DATE	SHEET NO. OF
CHECKED	DATE	DRAWING NO.

C:\Users\ryan.dummer\Horrocks Engineers\Civil Traffic Group - North Village Master Plan Transportation\Transportation\FFP\Intersection Layouts.dwg - 2-LANE ROUNDABOUT - 5/13/2022 03:29pm, ryan.dummer



THIS IS A GENERAL LAYOUT FOR THE INTERSECTIONS:
5, 8, 13, & 18

*THESE LOCATIONS NEED TO BE CONSIDERED INDIVIDUALLY

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE
HORIZONTAL N/A
VERTICAL N/A

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

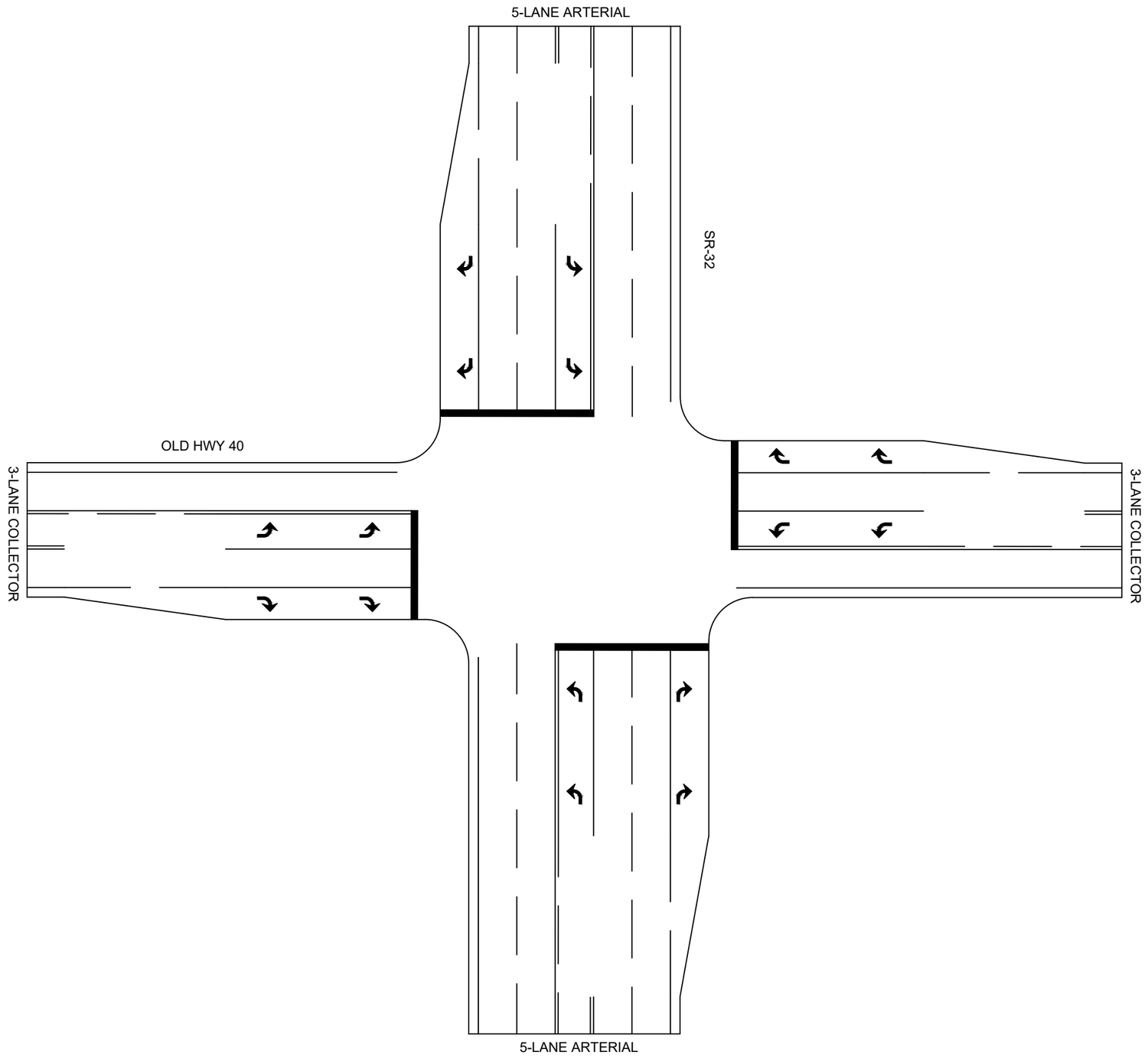
2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

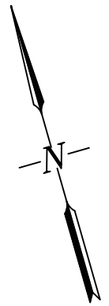
HEBER - NORTH VILLAGE

1-LANE ROUNDABOUT - 120 FT INSCRIBED CIRCLE

DESIGNED	DATE	PROJECT NO.
DRAWN	DATE	SHEET NO. OF
CHECKED	DATE	DRAWING NO.

C:\Users\ryan.dummer\Horrocks Engineers\Civil Traffic Group - North Village Master Plan Transportation\Transportation\IFFP\Intersection Layouts.dwg - 1-LANE ROUNDABOUT - 5/13/2022 01:21pm, ryan.dummer





C:\Users\jakep\Downloads\Intersection Layouts.dwg - SR-32 & OLD HWY 40 - 9/08/2022 04:05pm, jakep

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE	
HORIZONTAL	N/A
VERTICAL	N/A

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

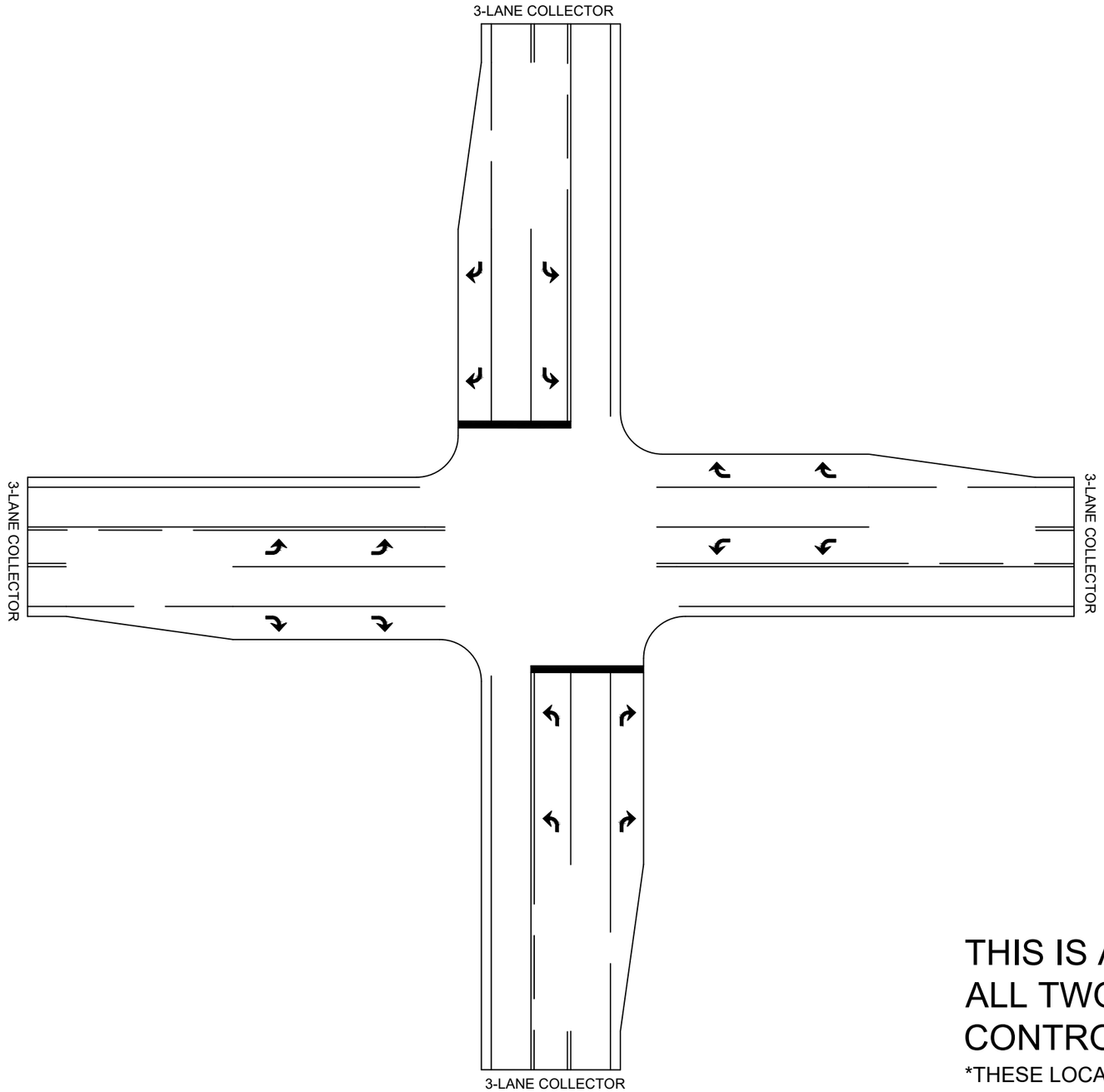
HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

HEBER - NORTH VILLAGE

SR-32 & OLD HWY 40 INTERSECTION LAYOUT

DESIGNED	DATE	PROJECT NO.
DRAWN	DATE	SHEET NO. OF
CHECKED	DATE	DRAWING NO.



THIS IS A GENERAL LAYOUT FOR ALL TWO-WAY STOP CONTROLLED INTERSECTIONS.

*THESE LOCATIONS NEED TO BE CONSIDERED INDIVIDUALLY

PRELIMINARY

NOT FOR CONSTRUCTION

SCALE

HORIZONTAL N/A

VERTICAL N/A

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

HEBER - NORTH VILLAGE

3-LANE 2-WAY STOP

DESIGNED	DATE	PROJECT NO.
DRAWN	DATE	SHEET NO. OF
CHECKED	DATE	DRAWING NO.

C:\Users\jakep\appdata\local\temp\AcPublish_12044\Intersection Layouts.dwg - 3-LANE 2-WAY STOP - 9/08/2022 04:06pm, jakep

4.2 Future Conditions

A variety of factors will affect the traffic and the street improvements needed to meet the future growth in Heber North Valley. Some of the sources of data used to determine the future traffic conditions and the proposed street improvements are:

- Population growth rates
- Utah Department of Transportation (UDOT) Road Classification Map
- Various Traffic Studies
- Projected Residential and Non-Residential development
- Heber City Transportation Plan

As these factors change, the timing of improvements recommended in this study could be affected. To help minimize this effect, the recommendations made in this study will be based upon the number of people served by Heber City's street system rather than time periods and/or external factors beyond the City's control.

Projected populations were used to determine where the new streets should be constructed based on the potential areas of development. Existing traffic patterns and Average Daily Traffic counts (ADT) were used to help project future traffic patterns and areas in need of road improvements. Future traffic models of the Heber Valley were compared with Heber City's adopted General Transportation Plan, UDOT's Road Classification Map for Heber City, and North Village Overlay Zone Plan. Each road was checked to confirm future road classifications and needed road widths to accommodate the projected growth.

The North Village Master Plan analysis included traffic modeling to evaluate the trip distribution onto the planned roadway network. The trips were assigned based on projected traffic according to the zoning and using ITE trip generation rates. See Table 3-2 in Chapter 3 which lists each planned development area and the associated number of residential units and non-residential square footage for each at build-out. The traffic model was based on full build-out. See Appendix 4 for the Vistro traffic volumes from the traffic model,

It is not yet known if some of the areas analyzed for the road network in this Master Plan will choose to remain in Wasatch County and not annex into Heber City. In those cases where this occurs, Heber City will coordinate with Wasatch County to develop a Memorandum of Understanding (MOU) to provide consistency and continuity of the road network across jurisdictions.

DRAFT

4.3 Street System Analysis and Level of Service

Street Impact Fees Administration

An impact fee is a one-time fee with the purpose of raising revenue for new or expanded public facilities required to serve new development and maintain the existing level of service. Impact fees cannot be used to correct existing roadway deficiencies or for routine maintenance activities. The premise behind impact fees is based on the critical assumption that if no new development were allowed, the existing street system would adequately serve the existing level of development in the City. Therefore, the recommended roadway improvements outlined in this Master Plan, should be used in the development of the impact fees. These improvements are growth related and are needed to accommodate the projected growth and maintain a minimum level of service "C" in the North Village.

Trip Generation Rates

Each area associated with a land use in the Heber City General Plan will generate traffic trips as the land is developed. The residential land uses allow for a variety of housing types. Each housing type was found in the *Institute of Transportation Engineers (ITE) Trip Generation Manual 11th Edition,* and the number of trips associated with each type was determined. Four categories were chosen, Single Family Detached Housing, Single Family Attached Housing (townhomes), Multifamily Housing, and Senior Housing to reflect the majority of housing in the North Village area. These housing types, and the respective trips they generate, were used to determine a proportionate share of improvement costs needed for each type. The multifamily and high-density types were averaged together to simplify the impact fee calculation and distribution of impact fees. The trip generation rates for residential land uses are summarized in **Table 4-5** below. See Appendix 5 for ITE Trip Generation information.

Table 4-5: Residential Trip Rates

Dwelling Unit Type	Trips Generated per Day
Single Family Detached Housing (210)	9.43
Single Family Attached Housing (215)	7.20
Multifamily Housing (220)	6.74
Senior Adult Housing – Single-Family (251)	4.31
Senior Adult Housing – Multifamily (252)	3.24

Because of the wide range of different types of commercial and industrial development that occur in North Village, non-residential impact fees are determined on an individual basis. The fee is based on the amount of new trips generated by the individual business. Each departure or arrival from a business or residence is counted as a trip, i.e., one car equals two trips. The average residential trip rate for North Village was calculated by multiplying the anticipated quantity of each housing type by the trip generation rate, then dividing by the total number of housing units. This was calculated to be 7.18 trips per residential unit in North Village. See Chapter 3 for more population information.

Table 4-6 shows the population growth rates used to project future trips into the year 2042.

Table 4-6: STREET POPULATION & ERU's

	POPULATION			RESIDENTIAL				NON-RESIDENTIAL					RES+NON-RES	
YEAR	% CHG	TOTAL	CHG	UNITS	CHG	NEW TRIP'S		% CHG	1000 SF	CHG	NEW TRIP'S		NEW TRIP'S	
						Trip's/Unit =					Avg Trip's/1000 Sq Ft =			
						7.18					21.34			
2022	0.00%	1,394		414					-				-	
2023	8.00%	1,506	112	449	36	257			-		-		257	
2024	8.00%	1,626	120	488	39	277			10	10	213		490	
2025	8.00%	1,756	130	530	42	299			20	10	213		512	
2026	8.00%	1,897	140	575	45	323		8.00%	30	10	213		536	
2027	8.00%	2,048	152	623	49	349	1,505	8.00%	32	2	51	691	400	2,196
2028	8.00%	2,212	164	676	53	377		8.00%	35	3	55		432	
2029	8.00%	2,389	177	733	57	407		8.00%	38	3	60		467	
2030	8.00%	2,580	191	794	61	440		8.00%	41	3	65		505	
2031	8.00%	2,787	206	860	66	475		8.00%	44	3	70		545	
2032	8.00%	3,010	223	931	71	513	2,212	8.00%	48	4	75	325	588	2,537
2033	8.00%	3,250	241	1,009	77	554		8.00%	51	4	81		635	
2034	8.00%	3,510	260	1,092	83	598		8.00%	56	4	88		686	
2035	8.00%	3,791	281	1,182	90	646		8.00%	60	4	95		741	
2036	8.00%	4,094	303	1,279	97	698		8.00%	65	5	102		800	
2037	8.00%	4,422	328	1,384	105	753	3,249	8.00%	70	5	111	477	864	3,726
2038	8.00%	4,776	354	1,498	113	814		8.00%	76	6	119		933	
2039	8.00%	5,158	382	1,620	122	879		8.00%	82	6	129		1,008	
2040	8.00%	5,570	413	1,752	132	949		8.00%	88	7	139		1,088	
2041	8.00%	6,016	446	1,895	143	1,025		8.00%	95	7	150		1,175	
2042	8.00%	6,497	481	2,049	154	1,107	4,774	8.00%	103	8	162	914	1,111	
TOTAL CHANGE (2022 to 2042)			5,103		1,561	11,206				93	1,980		13,028	
Ultimate Buildout			14,964		5,345	38,400			904		13,522		51,922	
EST 2022			1,394		414	3,502				-	213		3,716	
TOTAL 2042			6,497		1,975	14,708				93	2,193		16,744	

DRAFT

4.4 Economic Feasibility Analysis

Costs of the recommended Impact Fee Facilities for the full build-out are shown in **Table 4-7**. The estimated material and installation cost for the road improvements, intersections, and updates to this plan is $70,237,963. This number is based on 2022 material and labor costs and should be updated regularly to reflect changes in price.

It is anticipated that the recommended improvements will be funded by Impact Fees or Public Improvement Districts (PID's) created within North Village. This report does not include the impact fee analysis or a funding mechanism for the proposed Capital Improvements. The calculation, collection, and proposed implementation of impact fees will be presented in a separate study. The study should also include any proposed PID's and how they will work with together with the City for the administration of the Impact Fees in North Village area.

In past Master Plans Heber City has had a policy of subsidizing 45 percent of the Non-Residential Street impact fee to reduce the burden on businesses generating revenue for the City. The subsidy funds came from the City's general fund or another source to make up the difference. It is estimated that over the next 20 years, new business will generate an additional 13,522 trips. This Non-Residential subsidy was only applicable to businesses generating property tax revenue for Heber City. All others paid the full streets impact fee. This policy should be revisited with the City Council during the impact fee analysis study to confirm if it will continue.

DRAFT

NORTH VILLAGE STREET CAPITAL IMPROVEMENTS

ULT	CIP#	IMPROVEMENT DESCRIPTION	LENGTH / COST	LUMP SUM	LOCAL	MINOR COLLECTOR	MAJOR COLLECTOR	WIDTH ROW	WIDTH ASPHALT	ROW	PAVEMENT & UBC	GRANULAR FILL	CLEAR & GRUB	CURB & GUTTER	SIDEWALK	Chip Seal	OVERLAY EXIST	WIDENING	ENG CM INSP	COST
			ft	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	
	T-001	Road F - East of SR 32 to Local Road A	1,200				X	85	50	X	X	X	X	X	X				X	$1,602,084
	T-002	Road F - Road A to Moulton Ln	2,800				X	85	50	X	X	X	X	X	X				X	$3,738,197
	T-003	Road F - Moulton Ln to Road B	1,800				X	85	50	X	X	X	X	X	X				X	$2,403,126
	T-004	Road F - Road B to University Ave	1,000				X	85	50	X	X	X	X	X	X				X	$1,335,070
	T-005	Moulton Ln (shifted north) - US 40 to Road F	600				X	85	50	X	X	X	X	X	X				X	$801,042
	T-006*	Local Road A - Road F to Road B	4,000		X			62	32	X	X	X	X	X	X				X	$4,143,721
	T-007*	Local Road A - Road B to University Ave	1,700		X			62	32	X	X	X	X	X	X				X	$1,761,081
	T-008*	Road B - Road F to Road A	1,500			X		68	38	X	X	X	X	X	X				X	$1,687,625
	T-009*	University Ave - US 40 to Road F	1,200				X	95	60	X	X	X	X	X	X			X	X	$2,128,120
	T-010*	University Ave - Road F to Road A	1,400				X	85	50	X	X	X	X	X	X				X	$1,869,098
	T-011*	University Ave - Road A to Commons Blvd	1,300				X	85	50	X	X	X	X	X	X				X	$1,735,591
	T-012	Commons Blvd - University Ave to Road E	1,200				X	85	50	X	X	X	X	X	X				X	$1,602,084
	T-013	Commons Blvd- Road E to Valley Hills Blvd	1,100				X	85	50	X	X	X	X	X	X				X	$1,468,577
	T-014*	Commons Blvd - Valley Hills Blvd to Road D	600				X	85	50	X	X	X	X	X	X				X	$801,042
	T-015	Commons Blvd - US 40 to Road D	800				X	95	60	X	X	X	X	X	X			X	X	$1,418,747
	T-016*	Road C - University Ave to College Way	1,000			X		68	38	X	X	X	X	X	X				X	$1,125,083
	T-017	College Way - US 40 to Road C	500			X		68	38	X	X	X	X	X	X			X	X	$613,678
	T-018	College Way - Road C to Road D	700			X		68	38	X	X	X	X	X	X				X	$787,558
	T-019*	College Way - Road D to Collage PL	400			X		68	38	X	X	X	X	X	X				X	$450,033
	T-020	Road E - College PL to Commons Blvd	1400			X		68	38	X	X	X	X	X	X				X	$1,575,117
	T-021	Road D - College Way to Commons Blvd	1,600			X		68	38	X	X	X	X	X	X				X	$1,800,134
	T-022	Coyote View Dr - Commons Blvd to Fitzgerald D	3,800			X		68	38	X	X	X	X	X	X				X	$4,275,317
	T-023	Coyote View Dr - Fitzgerald Dr to Coyote Cyn Pk	1,700			X		68	38	X	X	X	X	X	X				X	$1,912,642
	T-024	Coyote Cyn Pkwy - Coyote View Dr to Timp Can	1,800			X		68	38	X	X	X	X	X	X				X	$2,025,150
	T-025	Valley Hills Blvd - Commons Blvd to Fitzgerald D	1,800			X		68	38	X	X	X	X	X	X				X	$2,025,150
	T-026	Fitzgerald Dr - US 40 to Ostler Peak Rd	800			X		68	38	X	X	X	X	X	X				X	$900,067
	T-027*	Fitzgerald Dr - Ostler Peak Rd to Valley Hills Blv	500			X		68	38	X	X	X	X	X	X				X	$562,542
	T-028*	Fitzgerald Dr - Valley Hills Blvd to Coyote View D	2,300			X		68	38	X	X	X	X	X	X				X	$2,587,692
	T-029	Ostler Peak Rd - Fitzgerald Dr to Coyote Cyn Pk	2,200		X			62	32	X	X	X	X	X	X				X	$2,279,047
	T-030	Valley Hills Blvd - Fitzgerald Dr to Coyote Cyn P	2,300			X		68	38	X	X	X	X	X	X				X	$2,587,692
	T-031	Coyote Cyn Pkwy - US 40 to Ostler Peak Rd	1,100				X	85	50	X	X	X	X	X	X			X	X	$1,693,579
	T-032*	Coyote Cyn Pkwy - Ostler Peak Rd to Valley Hill	900				X	85	50	X	X	X	X	X	X			X	X	$1,385,655
	T-033*	Coyote Cyn Pkwy - Valley Hills Blvd to Timp Can	1,700				X	85	50	X	X	X	X	X	X				X	$2,269,619
	T-034	Intersection 1 - UDOT Traffic Signal (SR 32)	$500,000	X															X	$690,000
	T-035	Intersection 3 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-036	Intersection 5 - Single Lane Roundabout	$750,000	X															X	$1,035,000
	T-037	Intersection 10 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-038	Intersection 8 - Single Lane Roundabout (2-Way	$750,000	X															X	$1,035,000
	T-039	Intersection 9 - Multi Lane Roundabout	$750,000	X															X	$1,035,000
	T-040	Intersection 13 - Single Lane Roundabout (2-Wa	$1,000,000	X															X	$1,380,000
	T-041	Intersection 16 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-042	Intersection 17 - Multi Lane Roundabout	$1,000,000	X															X	$1,380,000
	T-043	Intersection 18 - Multi Lane Roundabout	$1,000,000	X															X	$1,380,000
	T-044	Intersection 23 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-045	North Village Master Plan Update (5 yrs x 4 Time	$160,000	X																$192,000
		TOTAL STREETS:																**TOTAL:**		**$70,237,963**

NOTES:

- Road Widening assumes existing road asphalt is 26' wide. Upsizing is difference between existing and master planned asphalt width; ie. Local 32', Minor Collector 38', Major Collector 50', Minor Arterial 60'.
- UDOT Intersection Improvements are expected to have a cost of $0 incurred by Heber City.
- Percent paid by developers for road widening costs on existing roads: Major/Minor Locals 100%, Minor Collectors 83%, Major Collectors 75%.
- Percent paid by developers for cost to construct new roads: see above notes.
- Curb and gutter price storm drain system price of $105 per foot is for one side of the road. The formula multipies by 2 to cover boths side of the road and all of the storm drain system.
- Prices do not include bridges, blasting, retaining walls, relocation of utilities, or guardrails.
- Prices inlcudes oversizing of storm pipes and facilities due to road widing from Major Local. And also lenghting of culverts at drainage crossings.

* Includes a bridge over a canal.

The amounts in Table 4-7 only include engineering and construction costs to build the road cross section (clear & grub of road cross section area, excavation for road section curb to curb, subbase, road base, asphalt, and curb & gutter). Therefore, the costs in Table 4-7 exclude engineering and construction costs for the following items, which are anticipated to be included and paid for by developments as part of the developer contributions as these items are needed.

- Mass grading/earth moving/slope construction
- Bridges/box culverts
- Pipes under roadways at drainage crossings
- Rock blasting
- Slope stabilization/erosion control
- Retaining walls
- Guardrail
- Streetlights
- Decorative features/landscape
- Landscaping
- Etc.

See Appendix 6 for the complete streets cost summary including unit costs.

Developer Contributions

The City has a policy that developers are responsible for 100 percent of the cost of on-site improvements needed to serve their development. Developers are also responsible for extending off-site, full width street improvements needed to serve their development. Reimbursement for a portion of these costs may be available through reimbursement agreements for the purpose of collecting funds from future adjacent property owners that front the street. The City will also reimburse developers the cost to upgrade streets from a Major Local to a Minor Collector, Major Collector, or Minor Arterial if they are identified in this Master Plan and impact fee funds are available.

Streets are required to be extended either through or along the front of a development to the farthest property line to facilitate extension by future adjacent property owners.

Road Fund Sources

Class B and C road funds are part of a funding program established by the Utah Legislature in 1937 as a means of helping counties and incorporated municipalities for the improvement of roads and streets throughout the State. 30 percent of state highway user taxes and fees are allocated to the class B and class C road account. This is a restricted account to be used for the construction and maintenance of county roads and municipal streets that have been documented as eligible for funding according to regulations governing this fund. Class B and C road funds are distributed bi-monthly using the formula prescribed in Utah Code 72-2-108(2-5).

Other funding sources include state transportation taxes, grants, and UDOT Small Urban funds.

Chapter 5

North Village Storm Water Master Plan

5.1 Summary and Recommendations

Introduction

Population growth and development in North Village of Heber City has the potential to alter existing hillside drainage paths which could then ultimately have a negative impact on sensitive areas downstream. It is imperative that Heber City storm water requirements are followed, and the Impact Fee Facility improvements, as specified in this Master Plan, are implemented to ensure proper storm water control of North Village both now and in the future. The hydrology, water quality, and the storm water level-of-service of the Heber Valley should not be adversely affected by growth in North Village.

This chapter evaluates the storm drain requirements for the ultimate 2042 boundary area of North Village. Calculations and recommendations are based on the most recent City zoning and annexation plan for the North Village Overlay District (NOVZ). Recommendations are made to ensure that the drainage system remains adequate to meet the projected increases in storm water flow and water quality requirements. As development occurs, the recommended storm water facilities provided in this plan will be required, while maintaining historic discharge paths and channels. Storm Water retention will be implemented to prevent unwanted changes to the historic discharge patterns.

Recommended Impact Fee Facilities will all be within or near existing natural drainage channels, they include the following:

- Debris/retention basins upstream of developments
- Culverts under both the Timpanogos and Wasatch irrigation canals at each of the seven existing natural drainage channels
- Intermediate retention and infiltration areas within the natural drainage channels to maintain current infiltration of storm water runoff
- A final retention basin at the bottom of the drainage on the east side of US 40 to capture any remaining storm water runoff that has not been infiltrated upstream

DRAFT

The existing natural drainages of North Village hillside have been modeled by Ensign Engineering using EPA SWMM software with the following parameters:

- Hydrologic Method — SCS Curve Number
- Design Event — 100-Year Storm
- Retention Capacity — 24-hr, 100-Year Storm
- Natural Channel Buffer Zone — 50 feet min each side of Channel (100 feet total)

Storm Drain Discharge Standard

Storm water requirements for development in North Village are outlined in the Heber City Storm Water Design Manual, which is included in Appendix 7. Prior to development, all storm water from undeveloped areas will continue to collect in existing natural drainage channels and flow west. Once development occurs, the facilities listed in this Master Plan must be completed within the existing drainage channels to control and retain the 100-year flow through the natural drainages. All storm water runoff from developed areas must be retained on-site and not be comingled with undeveloped flow or discharged to the natural drainage channels. The retention volumes for storm water from development must be designed separately, therefore, developed flow shall not discharge to the natural drainages. The 100-year flow path for the flow from development must also be provided to show how the flow will be kept out of the natural drainages, and kept within the conveyance system, and consequently be contained in on-site retention areas.

Water Quality

Heber City values water quality and the Storm Water Design Manual (SWDM) includes water quality components for proposed developments. The SWDM includes a list of minimum water quality design features for development, and requires Low Impact Development (LID) measures to be incorporated by each development. See Appendix 7 and refer to the most recent edition of the SWDM for water quality requirements for development.

Utah Pollution Discharge Elimination System (UPDES) permits are also required on construction sites larger than one acre and on sites less than one acre if they are part of a common larger development. Measures to control water quality are recommended to be continued and implemented. Measures include public outreach, facilities inventory mapping, official construction site storm water runoff control, pollution prevention, and good housekeeping. It is also recommended that Heber City create and implement an official Storm Water Management Program in the near future, however, this is not part of the Impact Fee Facilities Plan.

Hazard Mitigation

As development occurs in North Village area, the risk to structures and life may potentially increase. The City would like to be cognizant of potential hazards in the area and the recommended improvements in this plan include basic retention projects to help reduce the risk of flooding and debris flow within the natural drainages. Each development is required to submit

a hazard analysis of the area to be developed and provide a plan to mitigate the hazards that are found. The hazard analysis and recommendations shall be prepared by a qualified Geotechnical and Geological expert who shall determine all potential hazards and provide recommendations for each. The hazard mitigations may compliment the projects proposed it in this plan. And as each development submits their analysis, the findings may be utilized in future Master Plan updates.

To reduce the risk of flooding and debris flow hazard in the natural drainages, any proposed crossing of a natural drainage channel such as road or trail crossings shall be designed so that the 100-year flow remains within the drainage channel. The drainage paths and the channel crossing shall be designed such that water and debris flow over the road and back down the channel if the culvert or overflow structures were to ever be plugged; the design shall also ensure to the extent practical no intermingling of storm water runoff from development and natural undeveloped flow. To assist in this endeavor, the design could also include designing the development's underground storm water conveyance system for the 100-year flow.

Ground Water

There are certain areas of North Village which may have shallow ground water tables. All new development is required to complete a geotechnical study which includes evaluations of groundwater levels in the development area. If shallow groundwater is discovered, or it is found that there is potential for shallow ground water from streams, channels, or canals nearby, the development is required to provide means of controlling the groundwater for all infrastructure and buildings. Additionally, retention basins and other water quality devices need to be designed such that they do not contaminate groundwater.

Recommended Impact Fee Facilities

The recommended capital improvements are shown in Figure EX-110, which includes a table containing details about each project. This figure includes a guide for the location of the planned future storm drain facilities and improvements for natural undeveloped flow within the existing natural drainage channels. The proposed improvements are designed strictly for undeveloped flow that enters the natural drainage channels. The timing of these projects will be directly related to the location of development, sequencing, and the need for natural drainage attenuation and control. As the projects are needed, developers will be responsible to design and construct the projects which will be paid for by reimbursements from the City via impact fees collected or from other funding mechanisms such as PID where applicable. The capacity of the projects illustrated in Figure EX-110 are at full development build-out with some conservancy in the assumed areas that will remain undeveloped. There will likely also be an intermediate phase of the recommended projects where not all the projects within each drainage basin can be constructed because the area that has been planned to be ultimately developed has not yet developed. The City will need to work with developers to ensure the intermediate phase of the storm water control still functions until the ultimate "built-out" scenario can be reached.

There are several areas where the natural drainage channels have been disturbed and/or filled in due to past development. These areas are mainly at the bottom or west end of the natural drainages near US 40. The methodology behind this Master Plan requires that these locations be

reestablished to allow the natural flow to continue downstream through the channel. The timing and need to reestablish the natural drainage channels will be dictated by the development schedules, location, and the need for the other Master Planned projects within each channel. As the Master Planned culverts at the canal crossings within the natural drainages are installed, the potential for flow within the natural drainages downstream of the canals is likely increased. This will trigger the need to reestablish the natural drainage channel downstream of the canals. The developments within the natural drainages that needs to be reestablished and the projects that trigger the need to reestablish the natural drainage channel shall be responsible to complete the channel reestablishment work. Reestablishing the natural drainage channel is not an Impact Fee Facilities Project, but shall be responsibility of the developers to complete with their developments.

The Impact Fee Facilities listed in this Master Plan were designed using EPA SWMM modeling software. The model considers the existing drainage basins/canyons of North Village, and uses elevation data, contributing area, and surface information within the entire area of North Village to produce peak flows for each drainage basin. Sizing of retention ponds and culverts have been optimized to minimize cost while ensuring that adequate capacity is provided. Each project is based on an ultimate build-out scenario with some safety factor on the size of the ultimate contributing basin undeveloped area. If the size of these basins is larger in the future due to reduced development area, then the model will need to be updated and the capacity updated to reflect the actual size of the drainage basins. Development will not all happen at once, therefore, there will be an intermediate phase where the designed facilities will not fully function as proposed. Therefore, the recommended improvements need to be sequenced to prevent unwanted discharge. The City will need to work with developers to ensure that the storm water collection and infiltration adequately functions during the intermediate stages of development.

Factors such as runoff curve number, time of concentration, and outflow curves, were taken into account to ensure that hydrographs are as accurate as possible and there is a reasonable balance obtained between performance and cost. This report only provides the required pond volumes. The actual required area needed is based on several adjustable factors such as pond depth and footprint perimeter alignment which cannot be finalized until the design and construction phase.

It is important to note that the use and capacity of existing canals, streams, and irrigation ditches, were not evaluated as part of this report. A capacity analysis of these facilities was beyond the scope of this Master Plan and is not being improved with this study nor by the Capital Facilities which may be funded by impact fees.

DRAFT

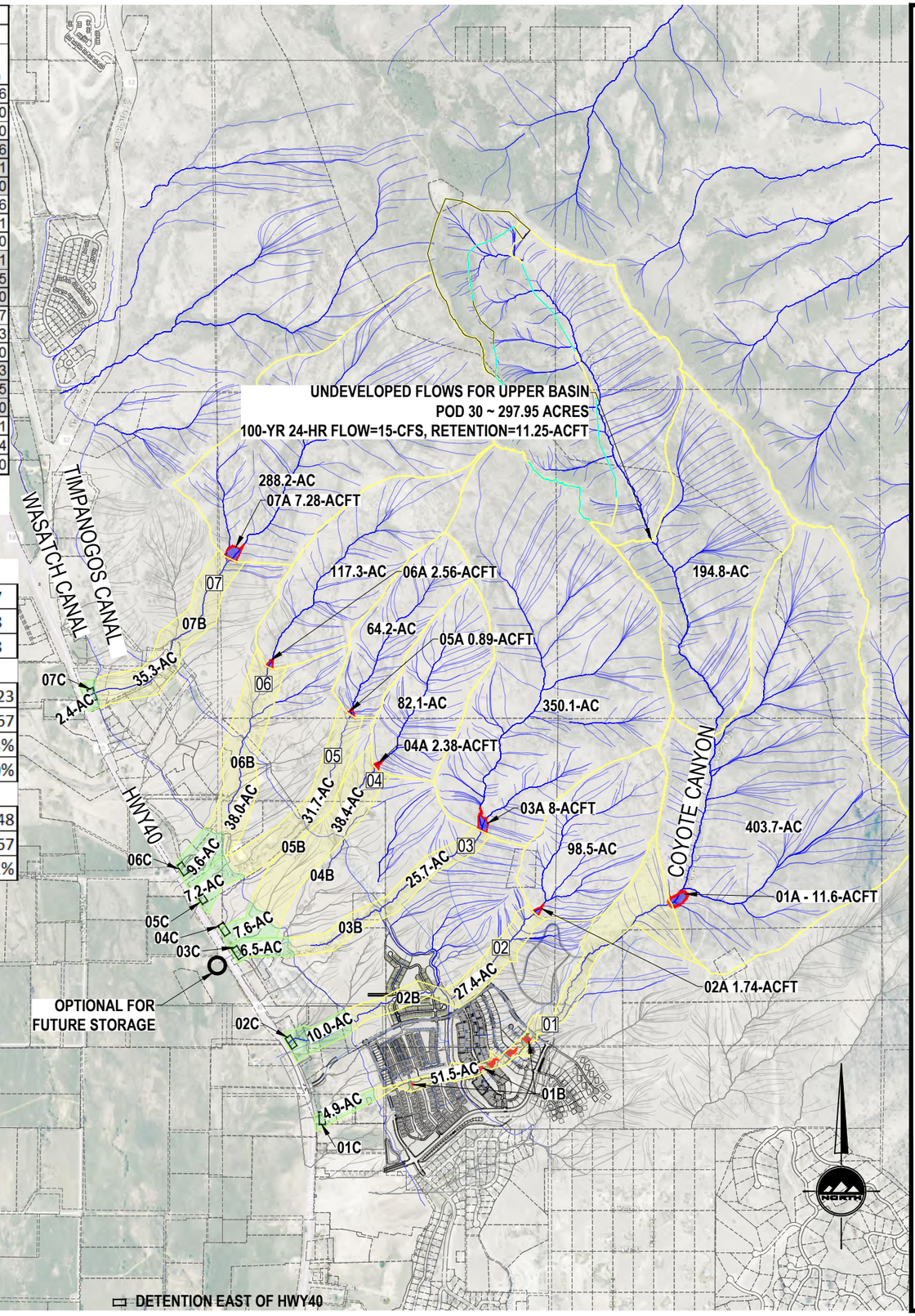
UNDEVELOPED FLOWS THROUGH JORDANELLE CANYONS WITH DRAINAGE IMPROVEMENTS

	STORAGE / LID MEASURE	HISTORIC 100-YR 24-HR PEAK IN (CFS)	HISTORIC 100-YR 24-HR STOR (ACFT)	INFIL. (IN/HR)	100-YEAR PEAK IN (CFS)	100-YEAR STOR (ACFT)	100-YEAR INFIL (ACFT)	25-YEAR PEAK IN (CFS)	25-YEAR STOR (ACFT)	25-YEAR INFIL (ACFT)	10-YEAR PEAK IN (CFS)	10-YEAR STOR (ACFT)	10-YEAR INFIL (ACFT)
01A	SEDIMENT BASIN	162	87	5.45	65.9	11.60	9.05	30.5	9.39	39.19	17.7	5.98	27.96
01B	ROADS / TRAILS			27	22.6	1.15	16.79	0.8	0.00	0.00	0.4	0.00	0.00
01C	EAST HWY 40 *			2	0.8	* 0.50	0.01	0.1	0.00	0.00	0.1	0.00	0.00
02A	SEDIMENT BASIN	33	13	2	25.3	1.74	0.80	10.2	1.74	4.76	5.4	1.48	3.66
02B	ROADS / TRAILS			2	11.9	2.06	2.19	1.4	0.00	0.98	0.2	0.00	0.11
02C	EAST HWY 40 *			2	1.2	* 0.50	0.02	0.2	0.00	0.00	0.1	0.00	0.00
03A	SEDIMENT BASIN	100	35	3.75	54.1	8.00	4.80	23.1	8.00	17.95	12.5	5.35	12.06
03B	ROADS / TRAILS			2	17.7	2.33	1.49	0.5	0.00	0.37	0.2	0.00	0.11
03C	EAST HWY 40 *			2	11.1	1.56	1.03	0.2	0.00	0.00	0.1	0.00	0.00
04A	SEDIMENT BASIN	42	12.5	1	23.1	2.38	0.36	9.6	1.59	3.69	4.8	1.16	3.21
04B	ROADS / TRAILS			1	2.7	0.42	1.01	0.7	0.00	0.46	0.3	0.00	0.15
04C	EAST HWY 40 *			1	1.0	* 0.50	0.01	0.2	0.00	0.00	0.1	0.00	0.00
05A	SEDIMENT BASIN	16	7	2.5	12.5	0.89	0.55	4.4	0.46	3.14	2.4	0.28	2.17
05B	ROADS / TRAILS			2	2.5	0.15	1.64	0.6	0.00	0.38	0.2	0.00	0.13
05C	EAST HWY 40 *			2	1.0	* 0.50	0.01	0.2	0.00	0.00	0.1	0.00	0.00
06A	SEDIMENT BASIN	41	14.5	3.75	80.5	2.56	1.32	32.9	1.61	6.72	14.5	1.14	4.63
06B	ROADS / TRAILS			2	2.7	0.18	1.83	0.7	0.00	0.45	0.3	0.00	0.15
06C	EAST HWY 40 *			2	1.2	* 0.50	0.04	0.2	0.01	0.01	0.1	0.00	0.00
07A	SEDIMENT BASIN	90	34	1.75	40.1	7.28	1.91	16.6	4.28	13.32	8.8	2.77	9.11
07B	ROADS / TRAILS			2	2.6	0.20	1.62	0.6	0.00	0.42	0.3	0.00	0.14
07C	EAST HWY 40 *			2	0.7	* 0.50	0.01	0.1	0.00	0.00	0.0	0.00	0.00

* Minimum basin size at bottom of all drainages (0XC) is 0.5-acft. Volumes and inflow listed are based on assumed undeveloped area and will need to be verified with individual overall drainage basin/development plans.

DEBRIS BASIN VOLUME SUMMARY

		01	02	03	04	05	06	07
Stormwater Volume Planned		13.60	3.80	11.89	2.80	1.04	2.74	7.48
With 0.5 acft minimum at Hwy 40		14.10	4.30	11.89	3.30	1.54	3.24	7.98
Cannon et al. equation (2010)	***Volume (ac-ft)***	14.10	2.33	8.68	2.09	1.54	3.00	7.23
10-year 60-minute depth (in)		0.867	0.867	0.867	0.867	0.867	0.867	0.867
% of Area over 30% Slopes		74%	54%	71%	58%	49%	65%	73%
	Percent Burn	80.7%	100.0%	100.0%	100.0%	94.17%	100.0%	100.0%
Gartner et al equation (2014)	***Volume (ac-ft)***	13.03	4.09	11.59	3.29	1.54	3.24	7.48
5-year 60-minute intensity (in/hr)		1.67	1.67	1.67	1.67	1.67	1.67	1.67
	Percent Burn	100.00%	100.00%	100.00%	73.40%	12.13%	13.65%	29.02%



HORIZONTAL GRAPHIC SCALE

2000 0 1000 2000 4000

(IN FEET)

HORZ: 1 inch = 2000ft.

ENSIGN
THE STANDARD IN ENGINEERING

SALT LAKE CITY
45 W. 10000 S., Suite 500
Sandy, UT 84070
Phone: 801.255.0529

LAYTON
Phone: 801.547.1100

TOOELE
Phone: 435.843.3590

CEDAR CITY
Phone: 435.865.1453

RICHFIELD
Phone: 435.896.2983

WWW.ENSIGNENG.COM

FOR:
MOMENTUM DEVELOPMENT GROUP, LLC
10421 SOUTH JORDAN GATEWAY BLVD, #200
SOUTH JORDAN, UTAH 84095
CONTACT:
DAVE BARBEE
PHONE: 801-316-3193

NORTH VILLIAGE
UNDEVELOPED DRAINAGE MASTER PLAN
700 COYOTE LANE
HEBER CITY, UTAH

UNDEVELOPED DRAINAGE
COYOTE CANYON
DISCHARGE VOLUMES
UPDATED INFIL RATES

PROJECT NUMBER 10229A
PRINT DATE 7/19/22
DRAWN BY C. DUNKEL
CHECKED BY B. MORGAN
PROJECT MANAGER B. MORGAN

EX-110

Impact Fee Facilities

The improvements recommended to meet the existing and future storm water control needs of North Village are provided in this section. These projects are only for attenuation and control of storm water from natural undeveloped areas near the channel. All storm water from development must be retained within each development.

D-01A Sediment Basin: 11.6 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 403.7 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 01 and below drainage basin 01A.

D-01B Roads/Trails: 1.2 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 01. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 01.

D-01C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 01 that is not retained by project 01A and 01B.

D-01D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 01.

D-01E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 01.

D-02A Sediment Basin: 1.7 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 95.8 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 02 and below drainage basin 02A.

D-02B Roads/Trails: 2.1AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 02. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 02.

D-02C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture

DRAFT

and retain/infiltrate any remaining flow in channel 02 that is not retained by project 02A and 02B.

D-02D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 02.

D-02E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 02.

D-03A Sediment Basin: 8.0 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 350.1 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 03 and below drainage basin 03A.

D-03B Roads/Trails: 2.3 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 03. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 03.

D-03C East Hwy 40 Detention: 1.6 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 03 that is not retained by project 03A and 03B.

D-03D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 03.

D-03E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 03.

D-04A Sediment Basin: 2.4 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 82.1 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 04 and below drainage basin 04A.

D-04B Roads/Trails: 0.4 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 04. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 04.

DRAFT

D-04C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 04 that is not retained by project 04A and 04B.

D-04D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 04.

D-04E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 04.

D-05A Sediment Basin: 0.9 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 64.2 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 05 and below drainage basin 05A.

D-05B Roads/Trails: 0.2 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 05. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 05.

D-05C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 05 that is not retained by project 05A and 05B.

D-05D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 05.

D-05E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 05.

D-06A Sediment Basin: 2.6 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 117.3 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 06 and below drainage basin 06A.

D-06B Roads/Trails: 0.2 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 06. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 06.

DRAFT

06C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 06 that is not retained by project 06A and 06B.

D-06D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 06.

D-06E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 06.

D-07A Sediment Basin: 7.3 AC-FT (Q100). This project is intended to be a dual-purpose use retention and infiltration area. Its primary purpose is to attenuate storm water from the 288.2 acre drainage basin above development and infiltrate it into the ground. The secondary purpose is to serve as a debris capture area and basin for post-fire flooding and debris flow. The need for this project will be initiated by development below the canals and within and near drainage channel 07 and below drainage basin 07A.

D-07B Roads/Trails: 0.2 AC-FT (Q100). This project is a series of retention and infiltration galleries that are anticipated to be built upstream of the road, canal, or trail crossing in drainage channel 07. However, this project does not necessarily need to be designed and completed with the road and/or canal crossings and could be simple retention/infiltration areas along the channel. The need for this project will be initiated by development above or below the canals and within or near drainage channel 07.

D-07C East Hwy 40 Detention: 0.5 AC-FT (Q100). This project is intended to capture and retain/infiltrate any remaining flow in channel 07 that is not retained by project 07A and 07B.

D-07D Timp Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Timpanogos Canal in drainage channel 06.

D-07E Wasatch Canal Crossing: 100 LF. This project is the pipe for the natural drainage to flow under the Wasatch Canal in drainage channel 06.

Economic Statement

The estimated cost of each Impact Fee Facilities project is listed in Table 5-3 in Section 5.4. The funding mechanism for these projects will likely be impact fees and/or Public Improvement Districts (PID), but may also include grants, third party contributions, or other sources. The calculation, collection, and proposed implementation of impact fees will be presented in a separate report, as well as the analysis and administration of any proposed Public Improvement Districts that may help fund the projects.

The maintenance of the storm drain systems and natural drainages will be funded by the storm drain utility fee charged to all existing residential and non-residential users. This fee would also

cover the cost of storm drain projects benefiting existing users, including street sweeping, and drainage maintenance. It is recommended that the current storm water utility fee be continued. The fees are currently $12.67/month for residential single family, multifamily less than an acre, and non-residential less than an acre. For multifamily residential and non-residential properties greater than an acre the fee is currently $9.86/acre/month with a maximum fee of $104.92/month for any parcel. This utility fee will generate the funds necessary for proper operation and maintenance of the City storm drain facilities. This fee should be charged to all developed property in North Village. The storm water utility fee should be reviewed annually to keep abreast of increasing inflation and construction cost indexes.

DRAFT

5.2 Existing and Future Growth Conditions

Population growth and development in North Village of Heber City has the potential to change the historic storm water drainage paths of the North Village hillside which would impact downstream channels and water bodies including the north fields west of US-189. The amount of precipitation runoff that is produced from a given area is related to the amount of water that infiltrates into the soil and/or is retained by vegetation. Alterations to soil and vegetation conditions cause less infiltration and retention and result in a larger amount of runoff. Constructing impervious surfaces such as roads, sidewalks, driveways, and homes in previously open areas increase the volume of water, rate of runoff, and concentration of pollutants in the runoff. These issues can change the hydrology and water quality, and result in a variety of problems, including habitat modification, increased flooding, decreased aquatic wildlife diversity, and increased sedimentation and erosion. It is imperative that guidelines are followed and needed improvements are implemented to ensure proper storm water control of North Village now and in the future. The hydrology and water quality of the Heber Valley shall not be adversely affected by growth in North Village.

Some of the sources and criteria used to determine future storm water control needs are:

- Growth projections
- Environmental regulations of EPA, FEMA, and DEQ
- Residential / non-residential development
- Heber City General Plan and zoning maps

Input and requests from various agencies and stakeholders in the Heber Valley have been taken into account with the production of this Master Plan. Some of the agencies and stakeholders include:

- Wasatch County and Health Department
- State of Utah Departement of Environmental Quality (DEQ)
- Provo River Water Shed Council (PRWC)
- Bureau of Reclamation (BOR)/Wasatch County Water Efficiency Project (WCWEP)
- United States of America Department of Interior (DOI)
- Utah Reclamation Commission
- Division of Wildlife Resources
- Utah Department of Agriculture and Food
- North Field Irrigation Company
- North Field Property Owners
- United States Geological Survey (USGS)

As factors change, or if new input is received, the recommendations made in this study could be affected. Continued communication with agencies and stake holders is important as this Master Plan is updated in the future. To minimize the effect of changing future conditions, recommendations made in this report are based upon future development, planned roadway improvements, recent water quality regulations, and the impact they may have upon future land uses. Storm drain improvement projects should be completed in conjunction with water quality

DRAFT

needs and land development.

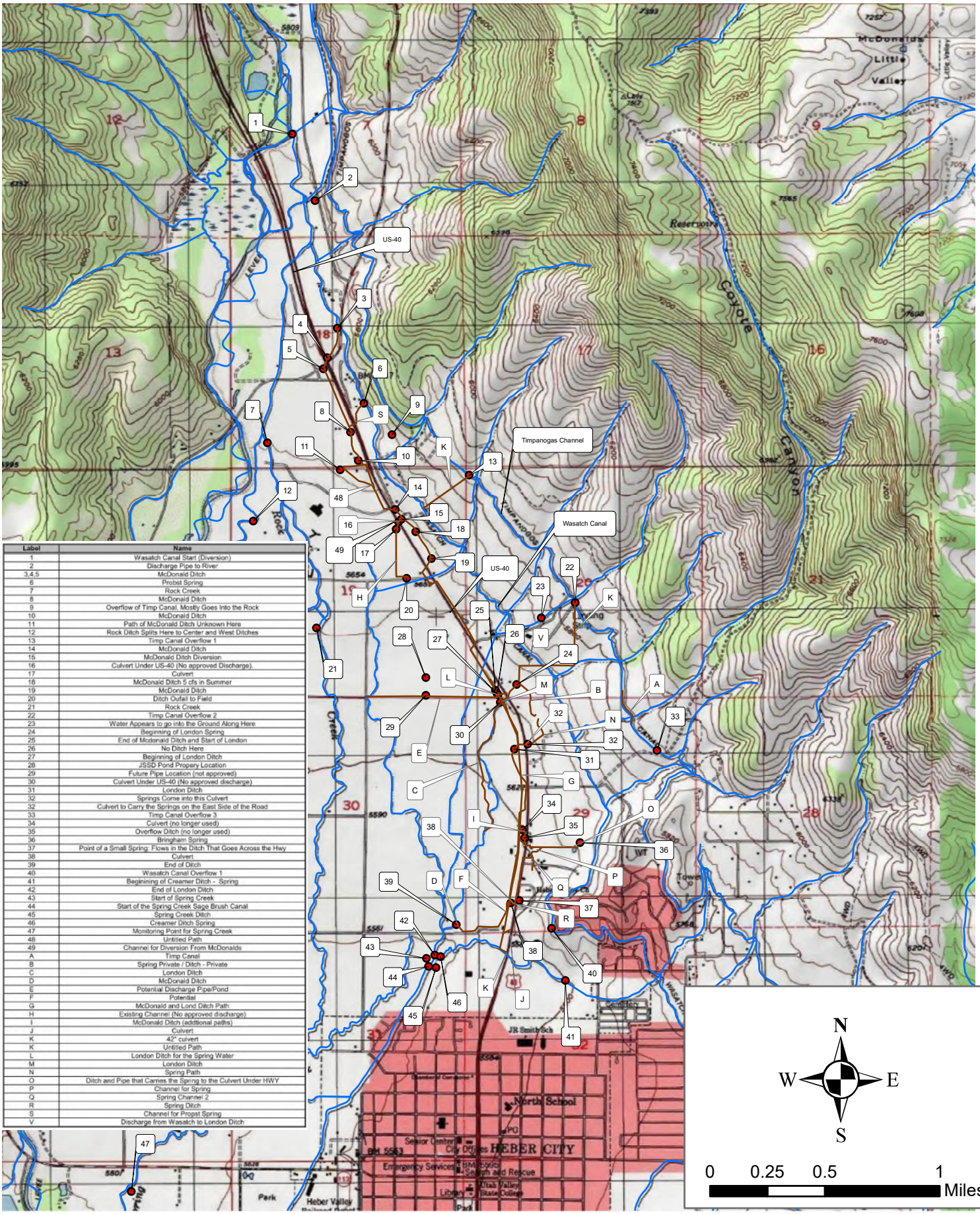
Existing North Village Drainage Basins

The existing topography of North Village consists of seven large canyons, one of which is Coyote Canyon. Natural drainage channels exist in each of these canyons which have served as outfalls for the natural undeveloped storm water. Historically these drainage outfalls continued west toward Provo River, but since the late 1800s these natural drainage channels have been cut off by the two federally owned canals that run north and south through the area. These canals were not sized for all of the storm drainage but have subsequently ended up collecting flow from the existing drainage basins. Historically, these canals could accommodate small storm events, but they can overtop and flood the surrounding area during larger events. Federal policy prohibits any storm water from development areas from discharging into these canals. See Appendix 8 for the Cross Drainage Flow Rates Summary map which summarizes data from an older drainage study completed for the WCWEP.

Existing Conditions & Map

North Village existing storm drain facilities are shown in Figure 5-1 Existing Drainage Features. This map was created from information gathered during meetings with WCWEP and North Fields Irrigation Company. Some of the labels are simply notes taken during the meeting and may not directly relate to existing facilities.

DRAFT



Label	Name
1	Wasatch Canal Start (Diversion)
2	Discharge Pipe to River
3,4,5	McDonald Ditch
6	Probst Spring
7	Rock Creek
8	McDonald Ditch
9	Overflow of Timp Canal, Mostly Goes Into the Rock
10	McDonald Ditch
11	Path of McDonald Ditch Unknown Here
12	Rock Ditch Splits Here to Center and West Ditches
13	Timp Canal Overflow 1
14	McDonald Ditch
15	McDonald Ditch Diversion
16	Culvert Under US-40 (No approved Discharge).
17	Culvert
18	McDonald Ditch 5 cfs in Summer
19	McDonald Ditch
20	Ditch Outfal to Field
21	Rock Creek
22	Timp Canal Overflow 2
23	Water Appears to go into the Ground Along Here
24	Beginning of London Spring
25	End of Mcdonald Ditch and Start of London
26	No Ditch Here
27	Beginning of London Ditch
28	JSSD Pond Propery Location
29	Future Pipe Location (not approved)
30	Culvert Under US-40 (No approved discharge)
31	London Ditch
32	Springs Come into this Culvert
32	Culvert to Carry the Springs on the East Side of the Road
33	Timp Canal Overflow 3
34	Culvert (no longer used)
35	Overflow Ditch (no longer used)
36	Bringham Spring
37	Point of a Small Spring: Flows in the Ditch That Goes Across the Hwy
38	Culvert
39	End of Ditch
40	Wasatch Canal Overflow 1
41	Beginining of Creamer Ditch - Spring
42	End of London Ditch
43	Start of Spring Creek
44	Start of the Spring Creek Sage Brush Canal
45	Spring Creek Ditch
46	Creamer Ditch Spring
47	Monitoring Point for Spring Creek
48	Untitled Path
49	Channel for Diversion From McDonalds
A	Timp Canal
B	Spring Private / Ditch - Private
C	London Ditch
D	McDonald Ditch
E	Potential Discharge Pipe/Pond
F	Potential
G	McDonald and Lond Ditch Path
H	Existing Channel (No approved discharge)
I	McDonald Ditch (additional paths)
J	Culvert
K	42" culvert
K	Untitled Path
L	London Ditch for the Spring Water
M	London Ditch
N	Spring Path
O	Ditch and Pipe that Carries the Spring to the Culvert Under HWY
P	Channel for Spring
Q	Spring Channel 2
R	Spring Ditch
S	Channel for Propst Spring
V	Discharge from Wasatch to London Ditch

HORROCKS ENGINEERS
728 West 100 South
Heber, UT 84032
(435) 654-2226

Existing Drainage Features

DATE 9/2/2022
DRAWN

Figure 5-1

Future Discharge of Storm Water

Several meetings and discussions with downstream stakeholders have taken place regarding storm water from North Village and it has been determined that due to the sensitive nature of the North Fields, the physical constraints, and respecting the wishes of the stakeholders who, based on the unique history relating to storm water in the area, want to see that no storm water discharge go to the North Fields or to the Provo River. Development in North Village will be required to fully retain all storm water from undeveloped and developed areas for the 100-year return period.

Storm Water from development is required to be fully retained per the Heber City Storm Water Design Manual and will not be allowed to discharge to the natural drainages or be combined with the natural runoff that flows to the drainage channels. The recommended improvements in the Plan are sized to handle only storm water from undeveloped areas after all the proposed development in North Village has been built. There is some safety factor in the assumed area that will remain undeveloped in and around the drainage channels, however, it is assumed that North Village will fully develop in the future and all of the storm water from development will be retained with each development area, while the storm water from undeveloped areas will remain in the natural drainage channel and be retained and infiltrated within the channel and master planned basins.

Although it is the intent of this Master Plan to maintain separation between natural and developed storm water runoff, because all storm water for the 100-year storm event will be retained on the east side of US 40 with no planned discharge to the North Fields, the City will consider allowing for the combining of these flows on a case-by-case basis when it can be shown that doing so will not compromise water quality or the other goals of this plan.

Non-fertilized and non-irrigated landscaping may be allowed to discharge to the natural drainages as capacity in the proposed projects allow and as approved by the City Engineer on a case-by-case basis.

Future Conditions for Natural Drainages

All major natural channels must maintain a buffer of open space and offset from development. This buffer is intended to help maintain water quality, prevent damage from flooding events, and maintain habitat and aesthetics. A minimum buffer width of 100-ft centered on the major natural drainage channel should be maintained. Development (including individual lots and buildings) is not allowed in the buffer zone. Additional landscaping, green space, trails, or other amenities may be allowed if it is shown they will not negatively affect water quality or compromise the other goals of the buffer area. Trails may also be allowed if they do not compromise the purpose of the buffer or create water quality concerns. All improvements proposed in the natural drainages shall be approved by the City.

Modeling of Storm Water Runoff for Master Planned Facilities

Ensign Engineering modeled the existing drainage basins with EPA SWMM using the SCS curve number method. Curve numbers were based on land cover and hydrologic soil groups.

Land cover was estimated using aerial imagery and hydrologic soil groups were taken from the USGS Web Soil Survey.

The following criteria were used:

- Hydrologic Method — SCS Curve Number
- Design Event — 100-Year Storm
- Retention Capacity — 24-hr, 100-Year Storm
- Natural Channel Buffer Zone — 50 feet each side of Channel (100 feet total)

Summary of Projected Storm Water Runoff

As part of the modeling projects, the North Village area was divided the seven major subbasins used to approximate the runoff of the storm water from the undeveloped areas remaining at the time of future build-out. Areas anticipated to be developed are not included in this study and will need to be modeled separately by each development. The subbasins included the upper area that that will remain undeveloped, the main channel area through the developed areas, and the lower portion near US-40. An upper retention basin, which will also serve as a post-fire debris basin, has been planned to reduce runoff and lessen the risk of downstream flooding. The middle and lower sections of the watershed will have various ponds, berms, and basins to act as a retention and infiltration system that contains the 100-year runoff event prior to reaching US 40. Pipes sized for the 100-year storm event are planned under each canal to help prevent water from entering the canals. See Figure EX-110 for additional information.

See Table 5-1 for a summary of the infiltration rates used in the model and storage volumes determined within each basin by the Model.

DRAFT

Table 5-1 North Village Storm Water Runoff Volumes from Undeveloped Areas

Storage / LID Measure		Infil. (In/Hr)	Min Required Storage (Ac-Ft)
1 A	Sediment Basin	5.45	11.6
1 B	Roads/Trails	27	1.15
1 C	East Hwy 40	2	0
2 A	Sediment Basin	2	1.74
2 B	Roads/Trails	2	2.06
2 C	East Hwy 40	2	0.01
3 A	Sediment Basin	3.75	8
3 B	Roads/Trails	2	2.33
3 C	East Hwy 40	2	1.56
4 A	Sediment Basin	1	2.38
4 B	Roads/Trails	1	0.42
4 C	East Hwy 40	1	0.01
5 A	Sediment Basin	2.5	0.89
5 B	Roads/Trails	2	0.15
5 C	East Hwy 40	2	0
6 A	Sediment Basin	3.75	2.56
6 B	Roads/Trails	2	0.18
6 C	East Hwy 40	2	0.02
7 A	Sediment Basin	1.75	7.28
7 B	Roads/Trails	2	0.2
7 C	East Hwy 40	2	0

See Figure EX-110 for the watershed delineations, flow rates, retention volumes and debris volumes. Infiltration rates were measured in the field at each drainage basin and a safety factor of two was applied for the study. A summary of the North Village Percolation Testing results is provided in Appendix 9.

Projected Development Area

The total drainage area of the watershed that encompasses North Village is 3,013 acres and the projected development area is 1,167 acres, south of SR 32 and east of US 40. See Appendix 10 for an outline of the drainage area. It is anticipated that much of this area will be annexed into Heber City in the future, and this Storm Water Master Plan covers the entire North Village area. However, some of North Village may not annex into the City but remain in the County. The components and recommendations of this Master Plan should not only apply to areas of North Village that are annexed into Heber City but also to areas that remain in Wasatch County. It is recommended that Heber City coordinate with Wasatch County to pursue a Memorandum of Understanding regarding enforcement of the requirements of this Master Plan regardless of whether properties in the North Village area annex into Heber City or develop in Wasatch County.

Future Growth

The projected residential and non-residential units and ERUs are determined using the growth numbers in Chapter 3. Total ERU's projected for 2042 equal 1,928 residential and 51 non-residential equivalent residential units (ERU's). This estimation is based on projected population growth and land use areas that are expected to develop in the next 20 years. These growth projections will be updated as Mountain Land Association of Governments (MAG) updates the population and growth projections for Heber City or as Heber City calculates new population projections for North Village. See Table 5-2 below, and see Chapter 3 for more information on population.

Future capital facility projects are dictated by maintaining the natural drainage channels and storm water conveyance from the undeveloped areas in North Village. The projects are proposed to be funded by the storm water impact fees which will be paid by new users. Public Improvement Districts may also be utilized.

Table 5-2 Projected Residential and Non-Residential Growth

	NORTH VILLAGE POPULATION				RESIDENTIAL			NON-RESIDENTIAL					RES+NON-RES	
YEAR	% CHG	TOTAL	CHG		ERU	CHG		% CHG	CONN	CHG	ERU's		ERU's	
											ERU'S/CONN			
											3.6			
2022	0.00%	1,394	0		414	-		0.00%	0.00	0.00	0.00		-	
2023	8.00%	1,506	112		447	33.09		0.00%	0.00	0.00	0.00		33.09	
2024	8.00%	1,626	120		482	35.74		0.00%	5.00	5.00	18.00		53.74	
2025	8.00%	1,756	130	362	521	38.60	107	0.00%	10.00	5.00	18.00	36.00	56.60	143
2026	8.00%	1,897	140		563	41.69		8.00%	15.00	5.00	18.00		59.69	
2027	8.00%	2,048	152		608	45.02		8.00%	16.20	1.20	4.32		49.34	
2028	8.00%	2,212	164		656	48.62		8.00%	17.50	1.30	4.67		53.29	
2029	8.00%	2,389	177		709	52.51		8.00%	18.90	1.40	5.04		57.55	
2030	8.00%	2,580	191	824	766	56.71	245	8.00%	20.41	1.51	5.44	37.47	62.16	282
2031	8.00%	2,787	206		827	61.25		8.00%	22.04	1.63	5.88		67.13	
2032	8.00%	3,010	223		893	66.15		8.00%	23.80	1.76	6.35		72.50	
2033	8.00%	3,250	241		964	71.44		8.00%	25.71	1.90	6.86		78.30	
2034	8.00%	3,510	260		1,042	77.16		8.00%	27.76	2.06	7.40		84.56	
2035	8.00%	3,791	281	1,211	1,125	83.33	359	8.00%	29.99	2.22	8.00	34.48	91.33	394
2036	8.00%	4,094	303		1,215	90.00		8.00%	32.38	2.40	8.64		98.63	
2037	8.00%	4,422	328		1,312	97.20		8.00%	34.97	2.59	9.33		106.52	
2038	8.00%	4,776	354		1,417	104.97		8.00%	37.77	2.80	10.07		115.05	
2039	8.00%	5,158	382		1,531	113.37		8.00%	40.79	3.02	10.88		124.25	
2040	8.00%	5,570	413	1,779	1,653	122.44	528	8.00%	44.06	3.26	11.75	50.66	134.19	579
2041	8.00%	6,016	446		1,785	132.24		8.00%	47.58	3.52	12.69		144.92	
2042	8.00%	6,497	481		1,928	142.82		8.00%	51.39	3.81	13.70		156.52	
TOTAL CHANGE (2022-2042)			5,103			1,514				51	51		1566	
EST 2022			1,394			414				0	0		414	
TOTAL 2042			6,497			1,928				51	51		1979	
ULTIMATE PER LANDUSE						14,964								

DRAFT

5.3 Storm Water Control and Level of Service

Maintaining Level of Service in North Village

The purpose of a storm drain system is to prevent damage to property and provide for a reasonable level of safety for the public. Safety risks associated with storm water include potential flooding and effects on water quality. The small amount of existing development in North Village controls storm water runoff through sumps, catch basins, collection pipes, street curb and gutter networks, and retention ponds. The existing level of service for storm water control in the North Village is good and there is no known risk of flooding risks to structures or life.

The high level of service for Storm Water Control in North Village needs to be maintained as growth and development continues. The City's Storm Water Design Manual (SWDM) provides requirements for storm water design throughout the City. In addition to the requirements found in the SWDM, recommended control methods for handling future storm water runoff from development in North Village include the following:

- Collaboration and Participation in this North Village Storm Water Master Plan
- Full retention of storm water to eliminate downstream discharge and to capture pollutants
- Pretreatment pollutant removal devices designed specifically for the project
- Construction site runoff control
- Regular maintenance and good housekeeping
- Public education and outreach on pollutant control
- Facility inventory management
- Storm Water Management Agreements

Note: Pretreatment type devices can be an additional method of increasing water quality like inlets, sumps and ponds, but need to be regularly maintained to function properly.

The U.S. Environmental Protection Agency (EPA) presently regulates the water quality released into streams from large cities. Although Heber is not considered a large city, the EPA has plans to place water quality restrictions on smaller cities in the future. In anticipation of stricter water quality regulations in the future, the City should continue to develop more advanced storm water control measures as well as provide additional storm water regulations.

Developer Storm Water Maintenance Agreements

Each development within North Village shall have a Storm Water Maintenance Agreement (SWMA) and associated Long-Term Storm Water Management Plan with Heber City. It is preferred that storm water from private roads and facilities will be conveyed and retained separately from public storm water from the City owned public roads and trails. The private HOAs will be required to maintain the pipes, inlets, water quality features, retention facilities, etc. for private systems. While the City will own and maintain their own facilities within the public roadways. If private and public storm water is combined within a development due to constraints that prohibit the facilities to remain separate, then the SWMA between the City and

developer must address maintenance of the shared facilities. See Appendix 7 for the Storm Water Design Manual which contains a sample SWMA and Associated Long-Term Storm Water Management Plan within its Appendix J.

Interlocal Discharge Agreements

Wasatch County Water Efficiency Project (WCWEP) - CUWCD and the BOR prohibit storm water discharge from development to enter the Wasatch and Timpanogos Canals. The City also has a non-written gentleman's agreement with WCWEP that prohibits the natural unattenuated storm water in the natural drainages from flowing directly into the Timpanogos and Wasatch Canals as the area develops downstream of the canals. Culverts are planned under the canal at each location where the canals cross the natural drainages. These will be installed with development that occurs in the area or as WCWEP and Heber City determine they are needed.

Wasatch County

This Master Plan is for the entire North Village area. Most of the area has not yet annexed into Heber City, but remains in unincorporated Wasatch County, although most of the area is expected to eventually annex into the City. The requirements of this Master Plan should not only apply to areas of North Village that are annexed into Heber City but also the areas that remain in Wasatch County. Heber City will coordinate with Wasatch County to develop a Memorandum of Understanding (MOU) to provide consistency and continuity for the Master Planned storm drain systems.

The County is currently looking into doing a study to combine storm drain efforts with the City and potentially install regional detention/retention facilities for water quality purposes. In June 2000 a study was done recommending four basins be constructed to reduce the amount of sediment and phosphorus entering into the Provo River system. As the City designs its own facilities, mutually beneficial opportunities should be investigated to incorporate features enhancing water quality and reducing the economic impact to both the City and County. As part of the SWMP's six minimum control measures, Heber City will work to reduce pollutant discharge to streams and water bodies which affect Wasatch County and other downstream users. Heber City should also coordinate with Wasatch County in the steps to create a Storm Water Management Program that will provide benefit countywide.

City Storm Water Management Program

Considering the growth in Heber City, an official Storm Water Management Program is needed. Heber City and/or the Heber Valley will soon be classified as a small municipal separate storm sewer system (MS4). The Utah Department of Environmental Quality (DEQ) Division of Water Quality (DWQ) has storm water management regulations and guidelines to help facilitate storm water control for a small MS4. The program could be a combined effort between Wasatch County and Heber City.

The following are guidelines Heber City currently has in place which support proper storm water management:

1. Heber City Ordinance 15.08.080 was put in place to help facilitate a variety of items with respect to home construction. The ordinance provides some building site storm water control requirements, and it also helps control debris and dirt in the roadway to reduce storm drain system contamination.
2. Construction sites greater than one acre or projects less than one acre that are part of a larger common plan of development are required to obtain a Utah Pollutant Discharge Elimination System (UPDES) permit. With the permit, the site must also have an approved Storm Water Pollution Prevention Plan (SWPPP). All SWPPP plans are reviewed by the City Engineer.
3. All new development in North Village must retain storm water at the 100-year storm event for retention.
4. All new developments must adhere to the most recent version of the City's Storm Water Design Manual.

In addition to the items listed above, Heber City will continue implementing the following storm water control guidelines:

1. Public Education and Outreach: City will continue public education and outreach efforts to promote a change in behavior by the public to reduce water quality impacts associated with pollutants in storm water runoff. This will include education efforts targeting residents, businesses, developers/contractors, and industrial facilities. The education and outreach will focus on specific pollutants and pollutant sources that impact downstream receiving waters including: sediments (dirt, clay, sand), fertilizer/pesticides (nutrients such as phosphorus and nitrogen), and chemicals/ hazardous wastes (oil/grease, fuels, paint, cleaning products, etc.). It is recommended the City work with the Provo River Watershed group and Wasatch County to identify specific guidelines and distribution packets.
2. Storm Water Facilities Inventory: The City will maintain a record map of all storm drain facilities, including all inlets, manholes, culverts, pipes, ponds, storage facilities, sumps, oil separator boxes, pollutant removal devices, discharge points, canals, streams, flood channels, and other pertinent storm drain facilities that discharge into State waters.
3. Construction Site Storm Water Runoff Control: City will develop and adopt an ordinance that requires the use of erosion and sediment control practices at construction sites. The ordinance shall at a minimum be equivalent with the technical requirements set forth in the UPDES Storm Water General Permit for Construction Activities found at http://waterquality.utah.gov/UPDES/stormwatercon.htm. The ordinance shall include the following: Sanctions to ensure compliance, for construction projects disturbing greater than or equal to one acre, and to projects less than one acre that are part of a larger common plan of development. Require construction operators to prepare a Storm Water Pollution Prevention Plan (SWPPP) and apply sediment and erosion control BMP's as necessary to protect water quality, reduce pollutant discharge, and control waste such as, but not limited to, discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste. It is recommended that the City use ordinance language previously approved and used by the Provo River Watershed Council.
4. Pollution Prevention and Good Housekeeping: The City will prepare an operations and maintenance program to complete and track the following items: Perform annual inspections to identify when cleaning and maintenance of public storm drain facilities is

DRAFT

needed. Clean all inlets, ponds, canals, streams, and other pertinent public storm drain facilities of all debris, trash, oil accumulations, and excess sediment buildup. Repair any failures of installed public infrastructure. Maintain all access to public storm drain facilities. Monitor the drainage of all storage facilities and facilitate the proper discharge or infiltration of water from storm drain facilities to reduce stagnant water areas. Prioritize storm sewer system maintenance, with the highest priority areas being maintained at the greatest frequency. Prepare a schedule for street and public owned parking lot sweeping. Follow inspection checklists and record keeping procedures for all cleaning and maintenance.

The four storm water control items listed above are a good start to direct Heber City towards adopting the necessary programs for a beneficial storm drain system. The DEQ Division of Water Quality general permit for storm water discharge from small MS4s contains more extensive guidelines and procedures that will help Heber City implement an official Storm Water Management Program (SWMP). The following is a summary of the key components in a SWMP:

1. Provisions to develop, implement, and enforce a SWMP designed to reduce the discharge of pollutants from the MS4, protect water quality, and satisfy the appropriate water quality requirements of the Utah Water Quality Act.
2. Six Minimum Control Measures:
    a. Public Education and Outreach and Storm Water Impacts
    b. Public Involvement/Participation
    c. Illicit Discharge Detection and Elimination (IDDE)
    d. Construction Site Storm Water Runoff Control
    e. Long-Term Storm Water Management in New Development and Redevelopment (Post-Construction Storm Water Management)
    f. Pollution Prevention and Good Housekeeping for Municipal Operations
3. Shared Responsibility: Implementation of one or more of the six minimum measures may be shared with another entity, or the entity may fully take over the measure.
4. Provisions to review and Update the Storm Water Management Program

There are additional requirements of a small MS4, other than the SWMP, when implementing a storm water discharge permit, such as non-storm water discharge control, record keeping, permit conditions, and penalties. A recommended project in the next several years, with the involvement of Wasatch County, is to adopt a voluntary SWMP that focuses on the four items required of a SWMP. The official SWMP documents should be created and implemented and followed until the EPA and DEQ decide a mandatory Permit for Discharge is required.

DRAFT

5.4 Economic Feasibility Analysis

Costs of the proposed new improvements are shown in Table 5-3. The estimated material and installation cost for the Impact Fee Facilities is $22,334,086. This number is based on material and labor rates that are current as of 2022, and estimates should be updated regularly to reflect changes inflation and the current construction cost index. See Appendix 11 for the complete storm water facility cost summary including unit costs.

It is anticipated that the recommended improvements will be funded by Impact Fees or Public Improvement Districts created within North Village, although other funding mechanisms such as grants or third-party contributions should also be considered. This report does not include the impact fee analysis or a funding mechanism for the proposed Capital Improvements. The calculation, collection, and proposed implementation of those impact fees will be presented in a separate study. The study should also include any proposed Public Improvement Districts and show how they will work with together with the City for the administration of the Impact Fees or other funding sources for the Storm Water Impact Fee Facilities recommended in North Village area.

DRAFT

Table 5-3 Estimated Cost of Storm Water Improvements.

		IMPROVEMENT DESCRIPTION	LENGTH, QUANTITY, COST	VOLUME	PEAK FLOW	DISTURBED AREA		LUMP SUM	PIPE SIZE	CASING SIZE	Upper Basin	Mid Basin	US 40 Basin	SITE RESTORE	IRR & LANDSCAPE	LAND	ENG CM INSP	TOTAL PROJECT COST
ULT				AF	CFS	AC		i	j	k	l	m	n	o	p	q	r	
	D-01A	Upper Detention Basin - Coyote	1	11.60	65.9	4.78					X			100%			X	$3,798,433
	D-01B	Intermediate Detention Basins - Coyote		1.15	22.6	0.93						X		100%		X	X	$755,851
	D-01C	US40 Retention Basin - Coyote	1	0.50	0.8	0.34							X		100%	X	X	$287,519
	D-01D	Timp Canal Crossing - Coyote	100						36	48							X	$297,596
	D-01E	Wasatch Canal Crossing - Coyote	100						36	48							X	$297,596
	D-02A	Upper Detention Basin - Fitzgerald	1	1.74	25.3	0.86					X			100%			X	$576,932
	D-02B	Intermediate Detention Basins - Fitzgerald		2.06	11.9	1.67						X		100%		X	X	$1,353,959
	D-02C	US40 Retention Basin - Fitzgerald	1	0.50	1.2	0.34							X		100%	X	X	$287,519
	D-02D	Timp Canal Crossing - Fitzgerald	100						36	48								$252,200
	D-02E	Wasatch Canal Crossing - Fitzgerald	100						36	48								$252,200
	D-03A	Upper Detention Basin - Commons	1	8.00	54.1	2.92					X			100%			X	$2,600,738
	D-03B	Intermediate Detention Basins - Commons		2.33	17.7	1.89						X		100%		X	X	$1,531,420
	D-03C	US40 Retention Basin - Commons	1	1.56	11.1	1.06							X		100%	X	X	$897,061
	D-03D	Timp Canal Crossing - Commons	100						36	48							X	$297,596
	D-03E	Wasatch Canal Crossing - Commons	100						36	48							X	$297,596
	D-04A	Upper Detention Basin - Highlands	1	2.38	23.1	1.02					X			100%			X	$781,302
	D-04B	Intermediate Detention Basins - Highlands		0.42	2.7	0.34						X		100%		X	X	$276,050
	D-04C	US40 Retention Basin - Highlands	1	0.50	1.0	0.34							X		100%	X	X	$287,519
	D-04D	Timp Canal Crossing - Highlands	100						36	48							X	$297,596
	D-04E	Wasatch Canal Crossing - Highlands	100						36	48								$252,200
	D-05A	Upper Detention Basin - UVU	1	0.89	12.5	0.78					X			100%			X	$312,142
	D-05B	Intermediate Detention Basins - UVU		0.15	2.5	0.12						X		100%		X	X	$98,589
	D-05C	US40 Retention Basin - UVU		0.50	1.0	0.34							X		100%	X	X	$287,519
	D-05D	Timp Canal Crossing - UVU	100						36	48								$252,200
	D-05E	Wasatch Canal Crossing - UVU	100						36	48								$252,200
	D-06A	Upper Detention Basin - Views	1	2.56	80.5	1.06					X			100%			X	$838,531
	D-06B	Intermediate Detention Basins - Views		0.18	2.7	0.15						X		100%		X	X	$118,307
	D-06C	US40 Retention Basin - Views	1	0.50	1.2	0.34							X		100%	X	X	$287,519
	D-06D	Timp Canal Crossing - Views	100						36	48							X	$297,596
	D-06E	Wasatch Canal Crossing - Views	100						36	48							X	$297,596
	D-07A	Upper Detention Basin - Crossings	1	7.28	40.1	2.01					X			100%			X	$2,334,237
	D-07B	Intermediate Detention Basins - Crossings		0.20	2.6	0.16						X		100%		X	X	$131,452
	D-07C	US40 Retention Basin - Crossings	1	0.50	0.7	0.34							X		100%	X	X	$287,519
	D-07D	Timp Canal Crossing - Crossings	180						36	48							X	$351,593
	D-07E	Wasatch Canal Crossing - Crossings	100						36	48								$252,200
	D-08A	Master Plan Updates every 5 years (4 times)	$120,000					X										$156,000
		TOTAL STORM DRAIN FACILITY COST:		45.50														**$22,234,086**

NV MASTER PLAN
2022 TO 2042

IMPACT FEE FACILITIES PLAN
FOR
STREET SYSTEM AND STORM WATER

NORTH VILLAGE MASTER PLAN 2022 TO 2042 APPENDIX

HEBER CITY

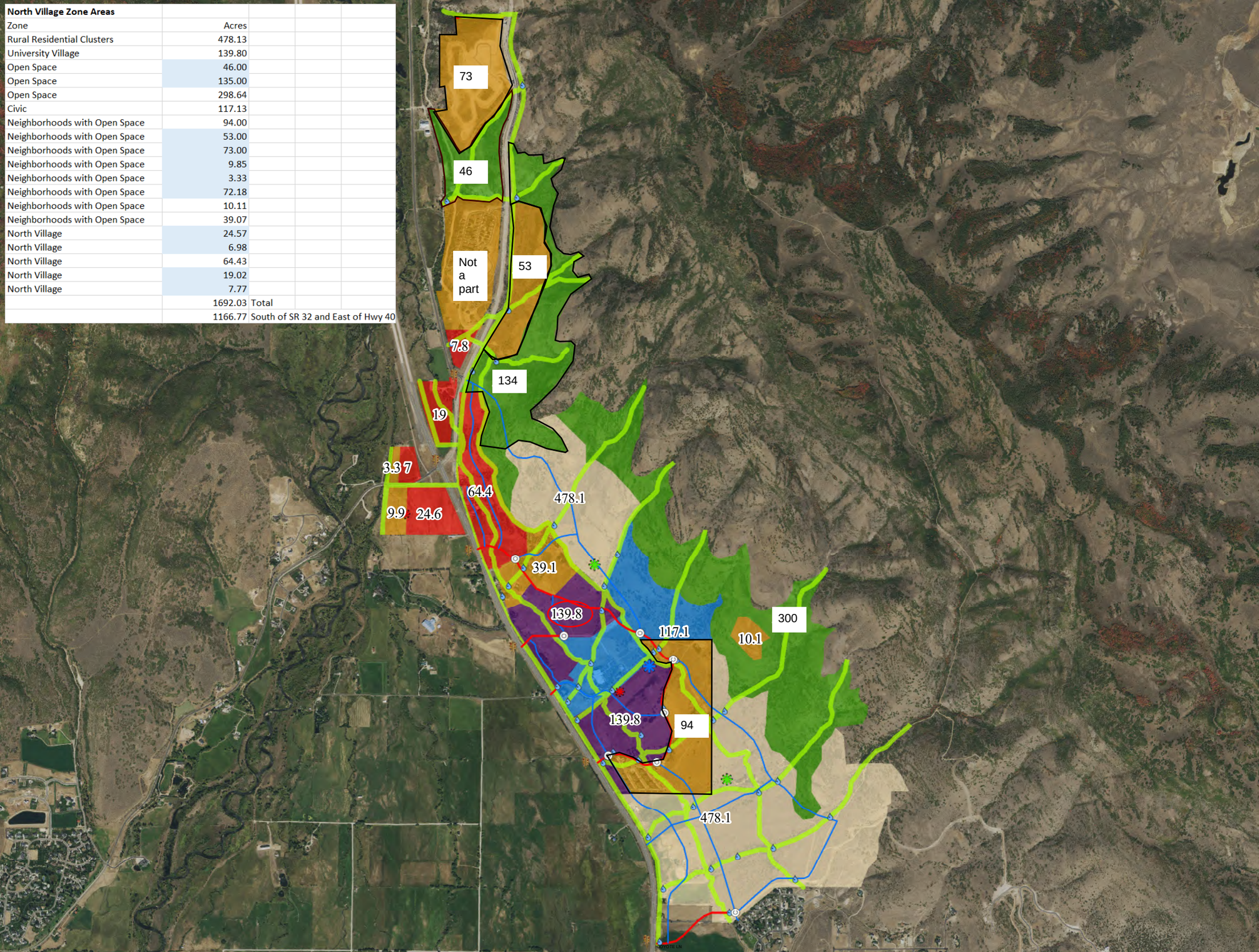
HEART OF THE WASATCH BACK

September 8, 2022

Prepared by
Heber City & Horrocks

Appendix 1
North Village Zone Areas

North Village Zone Areas				
Zone	Acres			
Rural Residential Clusters	478.13			
University Village	139.80			
Open Space	46.00			
Open Space	135.00			
Open Space	298.64			
Civic	117.13			
Neighborhoods with Open Space	94.00			
Neighborhoods with Open Space	53.00			
Neighborhoods with Open Space	73.00			
Neighborhoods with Open Space	9.85			
Neighborhoods with Open Space	3.33			
Neighborhoods with Open Space	72.18			
Neighborhoods with Open Space	10.11			
Neighborhoods with Open Space	39.07			
North Village	24.57			
North Village	6.98			
North Village	64.43			
North Village	19.02			
North Village	7.77			
	1692.03	Total		
	1166.77	South of SR 32 and East of Hwy 40		



Appendix 2
MAG and U.S. Census Bureau Population Data

Mountainland AOG Small Area Population and Employment Projections

2020-2050

	Population				*Employment			
	2020	2030	2040	2050	2020	2030	2040	2050
Summit County	42,829	50,558	57,983	63,097	39,605	46,410	52,538	58,535
Coalville	1,593	1,750	1,925	2,150	598	680	770	909
Francis	1,614	2,100	2,700	3,400	185	249	330	439
Henefer	1,060	1,200	1,325	1,425	117	137	156	177
Kamas	2,274	2,800	3,400	4,200	974	1,241	1,551	2,026
Oakley	1,834	2,150	2,500	2,900	354	429	514	630
Park City	8,517	8,758	8,893	8,961	21,441	23,696	25,255	27,158
Summit County	25,936	31,800	37,239	40,061	15,937	19,978	23,962	27,195
Utah County	679,188	861,852	1,080,082	1,297,515	325,797	405,681	493,054	593,648
Alpine	10,683	11,761	12,594	12,735	1,426	1,511	1,554	1,615
American Fork	32,855	40,752	48,846	51,391	30,817	33,813	36,894	39,804
Cedar Fort	671	773	1,855	11,845	54	337	848	1,215
Cedar Hills	10,483	10,442	10,288	10,232	1,103	1,314	1,476	1,513
Draper (UC)	2,678	2,886	3,034	3,078	0	0	0	0
Eagle Mountain	39,885	65,038	99,064	141,252	3,497	13,575	29,311	51,041
Elk Ridge	4,055	4,314	5,167	5,780	61	68	68	73
Fairfield	152	145	140	542	3	9	30	113
Genola	1,721	2,109	2,536	3,813	128	197	389	633
Goshen	1,009	1,185	1,671	2,095	32	43	63	100
Highland	19,337	21,257	23,375	24,250	2,438	2,574	2,956	2,959
Lehi	70,129	88,555	110,747	124,436	33,985	44,621	57,181	73,820
Lindon	12,135	13,105	13,564	13,719	13,492	16,299	18,356	21,336
Mapleton	12,390	16,480	19,726	21,724	1,314	2,619	3,309	3,912
Orem	99,814	105,540	117,630	127,517	65,226	67,664	66,876	66,535
Payson	22,436	30,341	42,728	64,887	8,868	10,492	13,793	21,552
Pleasant Grove	43,621	46,029	47,679	48,252	17,387	20,190	22,938	26,139
Provo	122,971	142,223	155,397	159,265	90,706	96,767	103,994	107,500
Salem	11,337	21,426	36,057	48,708	2,100	3,433	7,355	11,835
Santaquin	14,033	18,539	29,024	40,390	1,558	4,371	7,810	11,821
Saratoga Springs	39,085	79,815	117,641	138,600	7,997	24,108	39,164	52,322
Spanish Fork	44,793	58,643	79,575	93,509	21,777	27,389	34,137	41,673
Springville	37,758	48,562	58,174	61,969	17,664	24,942	30,700	36,947
Vineyard	14,887	24,017	33,870	36,265	3,757	8,900	13,381	18,505
Woodland Hills	1,694	1,824	2,018	2,200	0	0	0	0
Unincorporated UC	8,576	6,092	7,682	49,060	407	445	471	685
Wasatch County	35,713	48,168	59,665	68,904	12,992	15,534	17,948	20,370
Charleston	800	1,200	1,650	2,150	196	265	347	445
Daniel	1,125	1,691	2,000	2,400	97	132	148	175
Heber	18,250	23,500	27,800	32,500	8,801	10,213	11,477	13,215
Hideout	975	1,375	1,950	2,650	0	0	0	0
Independence	225	300	425	600	11	14	18	25
Interlaken	224	224	224	224	0	0	0	0
Midway	6,277	8,577	9,877	11,577	2,009	2,461	2,687	3,096
Wallsburg	364	366	386	401	18	18	18	19
Unincorporated WC	7,473	10,935	15,353	16,402	1,860	2,432	3,253	3,394

Gardner Policy Institute (GPI) 2017 Long-term projections county-level data is used to control small area projections.

GPI produces county projections through 2065. Small area data is only projected by MAG to 2050.

Produced by Tim Hereth | 801/229-3843 | thereth@mountainland.org

**Employment Data does not include agriculture, mining, or construction jobs.*

Comments from Discussion with Tim 9/1/2022

HC population includes the main part of the NV map he sent but not past SR 32

MAG current has it at 28,500 in 2040

The new model has the JR Plat B and C as well.

He does not see the trends changing, so they may be able update the numbers based on trends

QuickFacts

Heber city, Utah

QuickFacts provides statistics for all states and counties, and for cities and towns with a ***population of 5,000 or more***.

Table

PEOPLE	
Population	
Population Estimates, July 1 2021, (V2021)	⚠ 17,290
Population estimates base, April 1, 2020, (V2021)	⚠ 16,831
Population, percent change - April 1, 2020 (estimates base) to July 1, 2021, (V2021)	⚠ 2.7%
Population, Census, April 1, 2020	16,856
Population, Census, April 1, 2010	11,362
Age and Sex	
Persons under 5 years, percent	⚠ 8.8%
Persons under 18 years, percent	⚠ 33.8%
Persons 65 years and over, percent	⚠ 7.2%
Female persons, percent	⚠ 50.2%
Race and Hispanic Origin	
White alone, percent	⚠ 91.0%
Black or African American alone, percent (a)	⚠ 0.8%
American Indian and Alaska Native alone, percent (a)	⚠ 0.4%
Asian alone, percent (a)	⚠ 1.8%
Native Hawaiian and Other Pacific Islander alone, percent (a)	⚠ 0.0%
Two or More Races, percent	⚠ 3.1%
Hispanic or Latino, percent (b)	⚠ 17.6%
White alone, not Hispanic or Latino, percent	⚠ 78.7%
Population Characteristics	
Veterans, 2016-2020	324
Foreign born persons, percent, 2016-2020	10.0%
Housing	
	X

All Topics	Heber city, Utah
Housing units, July 1, 2	
Owner-occupied housi	
Median value of owner	
Persons per household, 2016-2020	**3.48**
Median selected monthly owner costs -with a mortgage, 2016-2020	$1,769
Median selected monthly owner costs -without a mortgage, 2016-2020	$441
Median gross rent, 2016-2020	$1,222
Building permits, 2021	X
Families & Living Arrangements	
Households, 2016-2020	4,651
Persons per household, 2016-2020	**3.48**
Living in same house 1 year ago, percent of persons age 1 year+, 2016-2020	83.4%
Language other than English spoken at home, percent of persons age 5 years+, 2016-2020	17.2%
Computer and Internet Use	
Households with a computer, percent, 2016-2020	96.8%
Households with a broadband Internet subscription, percent, 2016-2020	93.6%
Education	
High school graduate or higher, percent of persons age 25 years+, 2016-2020	93.9%
Bachelor's degree or higher, percent of persons age 25 years+, 2016-2020	37.9%
Health	
With a disability, under age 65 years, percent, 2016-2020	5.7%
Persons without health insurance, under age 65 years, percent	⚠ 8.2%
Economy	
In civilian labor force, total, percent of population age 16 years+, 2016-2020	74.6%
In civilian labor force, female, percent of population age 16 years+, 2016-2020	67.5%
Total accommodation and food services sales, 2017 ($1,000) (c)	D
Total health care and social assistance receipts/revenue, 2017 ($1,000) (c)	D
Total transportation and warehousing receipts/revenue, 2017 ($1,000) (c)	16,348
Total retail sales, 2017 ($1,000) (c)	265,083
Total retail sales per capita, 2017 (c)	$16,804
Transportation	
Mean travel time to work (minutes), workers age 16 years+, 2016-2020	20.9
Income & Poverty	
Median household income (in 2020 dollars), 2016-2020	$80,417
Per capita income in past 12 months (in 2020 dollars), 2016-2020	$30,100
Persons in poverty, percent	⚠ 5.2%
BUSINESSES	
Businesses	
Total employer establishments, 2020	X
Total employment, 2020	X

Total annual payroll, 20	
Total employment, perc	
Total nonemployer esta	
All employer firms, Reference year 2017	562
Men-owned employer firms, Reference year 2017	342
Women-owned employer firms, Reference year 2017	88
Minority-owned employer firms, Reference year 2017	S
Nonminority-owned employer firms, Reference year 2017	480
Veteran-owned employer firms, Reference year 2017	S
Nonveteran-owned employer firms, Reference year 2017	494

All Topics

Persons per household, 2016-2020	Heber city, Utah
	3.48

GEOGRAPHY

Geography	
Population per square mile, 2020	1,874.1
Population per square mile, 2010	1,351.4
Land area in square miles, 2020	8.99
Land area in square miles, 2010	8.41
FIPS Code	4934200

About datasets used in this table

All Topics	Heber city, Utah
Persons per household, 2016-2020	**3.48**

Value Notes

⚠ Estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info ⓘ icon to the left of each row in TABLE view to learn about sampling error.

The vintage year (e.g., V2021) refers to the final year of the series (2020 thru 2021). Different vintage years of estimates are not comparable.

Users should exercise caution when comparing 2016-2020 ACS 5-year estimates to other ACS estimates. For more information, please visit the 2020 5-year ACS Comparison Guidance page.

Fact Notes

(a) Includes persons reporting only one race
(c) Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
(b) Hispanics may be of any race, so also are included in applicable race categories

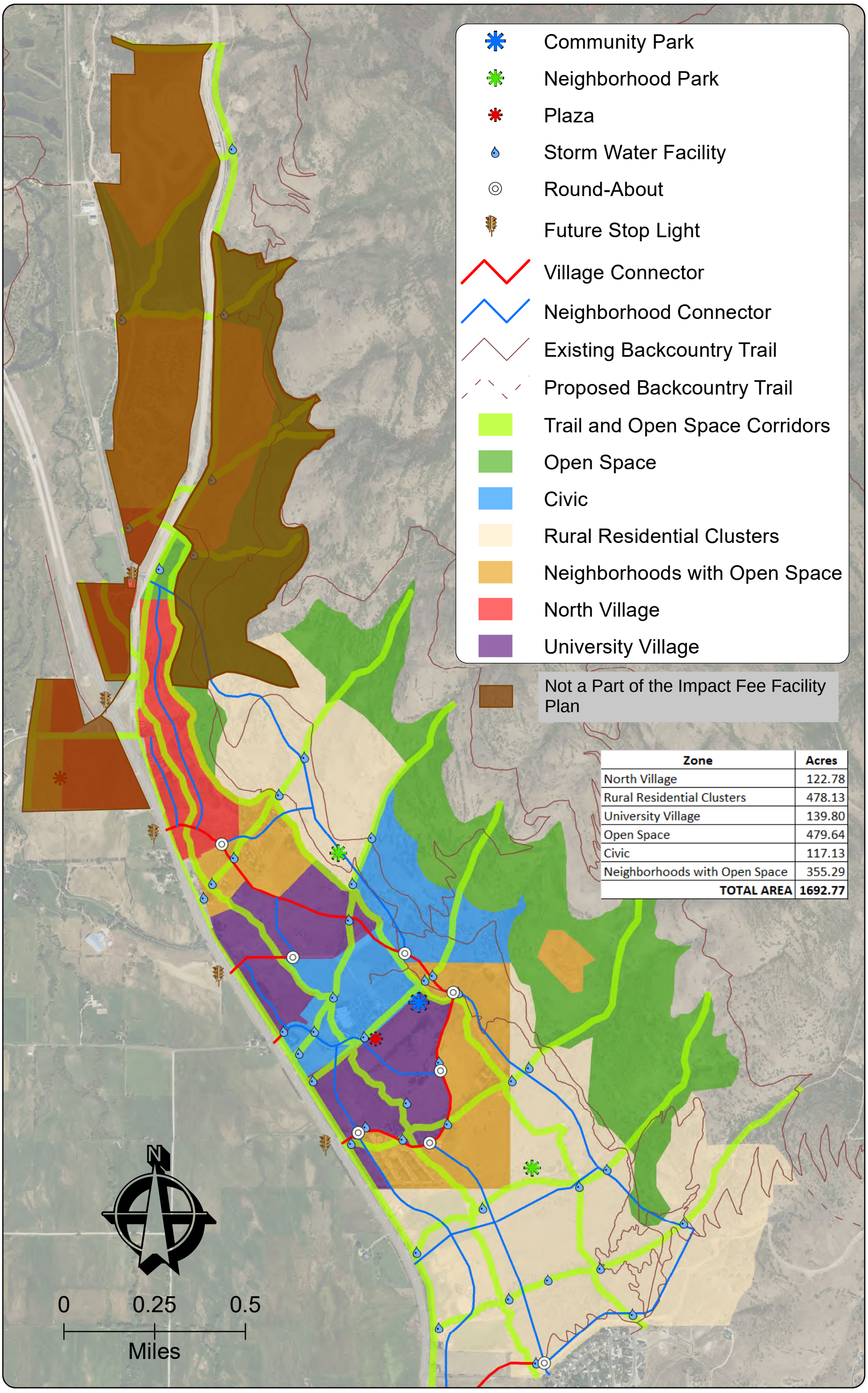
Value Flags

- Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper interval of an open ended distribution.
F Fewer than 25 firms
D Suppressed to avoid disclosure of confidential information
N Data for this geographic area cannot be displayed because the number of sample cases is too small.
FN Footnote on this item in place of data
X Not applicable
S Suppressed; does not meet publication standards
NA Not available
Z Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and Poverty Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.

Appendix 3

North Village Study Area and NVOZ Densities



Zone	Acres
North Village	122.78
Rural Residential Clusters	478.13
University Village	139.80
Open Space	479.64
Civic	117.13
Neighborhoods with Open Space	355.29
TOTAL AREA	**1692.77**

North Village Community Design Map

2.1 DENSITY

1. Base Sub-District Density Allocation Per Gross Acre: Overall property averages are subject to any Master Development Agreement (MDA) or Annexation Agreement (AA) documentation or any previously formal entitlements from approved plans for this particular property from Wasatch County government. Such agreements may include North Fields preservation requirements or the payment of fees for open space/agricultural land preservation.

    1. NV: 4.5 ERUs per gross acre base density

    2. NOS: 3.5 ERUs per gross acre, clustering required.

    3. UV: Six ERUs per gross acre base density

    4. RR: Two ERUs per gross acre, clustering encouraged.

    These densities are essentially ranges that not all properties will be able to achieve. They are contingent on site design considerations, sensitive lands avoidance, City Stormwater Standards, water availability, as well as Federal, State, and local service providers/stakeholders processes and approvals, All development/ERUs may be subject to a negotiated preservation fee paid at the time of recording of any plats, in return for the increased flexibility provided for in this ordinance. As part of the overall residential density calculation, commercial ERUs (.86 ERU per every 2000 sq ft) shall be included in the residential density calculation.

2.ERU Density Definitions

    1. Incremental increase will be 0.10 ERU per 500 square feet. For planning purposes only, a detached single-family home shall be 1 ERU per dwelling, regardless of the size of the home.

ERU Uses (1)	Notes	ERUs
Hotel or Motel Room, RV Pad, Transient Housing, Small Studio or Student Housing Unit	Not to exceed 500	0.25
One Bedroom: Hotel Room, Apartment or Condo	Not to exceed 800 sf	0.33
One or Two Bedroom: Apartment, Townhome, Cottage Home (detached SFD when part of a PUD) or Condo	Not to exceed 1,200 sf	0.50
Apartment, condo, or Townhouse	No to exceed 1,200 sf	0.75
All Other Residential Uses	Detatched Single-family and other residential units over 1,600 sf	1.0

Appendix 4
Vistro Traffic Volumes

Vistro Traffic Volumes

	Roadway Segment	Vistro Daily	Redistributed Daily Traffic Volumes
T-001	Old Highway 40 - West of SR 32	2430	2500
T-002	Old Highway 40 - East of SR 32 to Local Road A	2076	2100
T-003	Old Highway 40 - Local Road A to Moulton Lane	8606	8600
T-004	Old Highway 40 - Moulton Lane to Road B	3198	3200
T-005	Old Highway 40 - Road B to North of University Avenue	4725	4800
T-006	Moulton Lane shifted north - US 40 to Old Hwy 40	5709	5700
T-007	Local Road A - Old Hwy 40 to Road B	426	500
T-008	Local Road A - Road B to University Ave	2609	2600
T-009	Road B - Old Hwy 40 to Local Road A	1089	1100
T-010	University Ave - US 40 to Old Hwy 40	16041	16000
T-011	University Ave - Old Hwy 40 to Local Road A	6842	5800
T-012	University Ave - Local Road A to Coyote Lane/Commons Blvd	1500	2500
T-013	Commons Blvd - Coyote Lane to Road E	2303	3600
T-014	Commons Blvd- Road E to Valley Hills Blvd	1993	2400
T-015	Commons Blvd - Valley Hills Blvd to Road D	5206	5200
T-016	Commons Blvd - US 40 to Road D	13830	13900
T-017	Road C - University Ave to College Way	6066	6100
T-018	College Way - US 40 to Road C	3661	4500
T-019	College Way - Road C to Road D	2468	2500
T-020	College Way - Road D to Road E	2863	2900
T-021	Road E - College Way to Commons Blvd	4481	4500
T-022	Road D - College Way to Commons Blvd	8740	8100
T-023	Coyote Canyon View - Commons Blvd to Road F	100	<500
T-024	Coyote Canyon Parkway - Road F to bridge over Timpanogos Canal	2638	2700
T-025	Valley Hills Blvd - Commons Blvd to Road F	454	500
T-026	Road F - US 40 to Road G	1623	2500
T-027	Road F - Road G to Valley Hills Blvd	1151	2100
T-028	Road F - Valley Hills Blvd to Coyote Lane	1155	1200
T-029	Road G - Road F to Coyote Lane	1860	1900
T-030	Valley Hills Blvd - Road F to Coyote Lane	2822	2800
T-031	Coyote Lane - US 40 to Road G	10082	9200
T-032	Coyote Lane - Road G to Valley Hills Blvd	7701	6800
T-033	Coyote Canyon Parkway - Valley Hills Blvd to bridge over Timpanogo	2606	2600

Appendix 5
ITE Trip Generation

Land Use: 210
Single-Family Detached Housing

Description

A single-family detached housing site includes any single-family detached home on an individual lot. A typical site surveyed is a suburban subdivision.

Specialized Land Use

Data have been submitted for several single-family detached housing developments with homes that are commonly referred to as patio homes. A patio home is a detached housing unit that is located on a small lot with little (or no) front or back yard. In some subdivisions, communal maintenance of outside grounds is provided for the patio homes. The three patio home sites total 299 dwelling units with overall weighted average trip generation rates of 5.35 vehicle trips per dwelling unit for weekday, 0.26 for the AM adjacent street peak hour, and 0.47 for the PM adjacent street peak hour. These patio home rates based on a small sample of sites are lower than those for single-family detached housing (Land Use 210), lower than those for single-family attached housing (Land Use 251), and higher than those for senior adult housing -- single-family (Land Use 251). Further analysis of this housing type will be conducted in a future edition of *Trip Generation Manual*.

Additional Data

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

For 30 of the study sites, data on the number of residents and number of household vehicles are available. The overall averages for the 30 sites are 3.6 residents per dwelling unit and 1.5 vehicles per dwelling unit.

The sites were surveyed in the 1980s, the 1990s, the 2000s, and the 2010s in Arizona, California, Connecticut, Delaware, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Minnesota, Montana, New Jersey, North Carolina, Ohio, Ontario (CAN), Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Vermont, Virginia, and West Virginia.

Source Numbers

100, 105, 114, 126, 157, 167, 177, 197, 207, 211, 217, 267, 275, 293, 300, 319, 320, 356, 357, 367, 384, 387, 407, 435, 522, 550, 552, 579, 598, 601, 603, 614, 637, 711, 716, 720, 728, 735, 868, 869, 903, 925, 936, 1005, 1007, 1008, 1010, 1033, 1066, 1077,1078, 1079

Single-Family Detached Housing
(210)

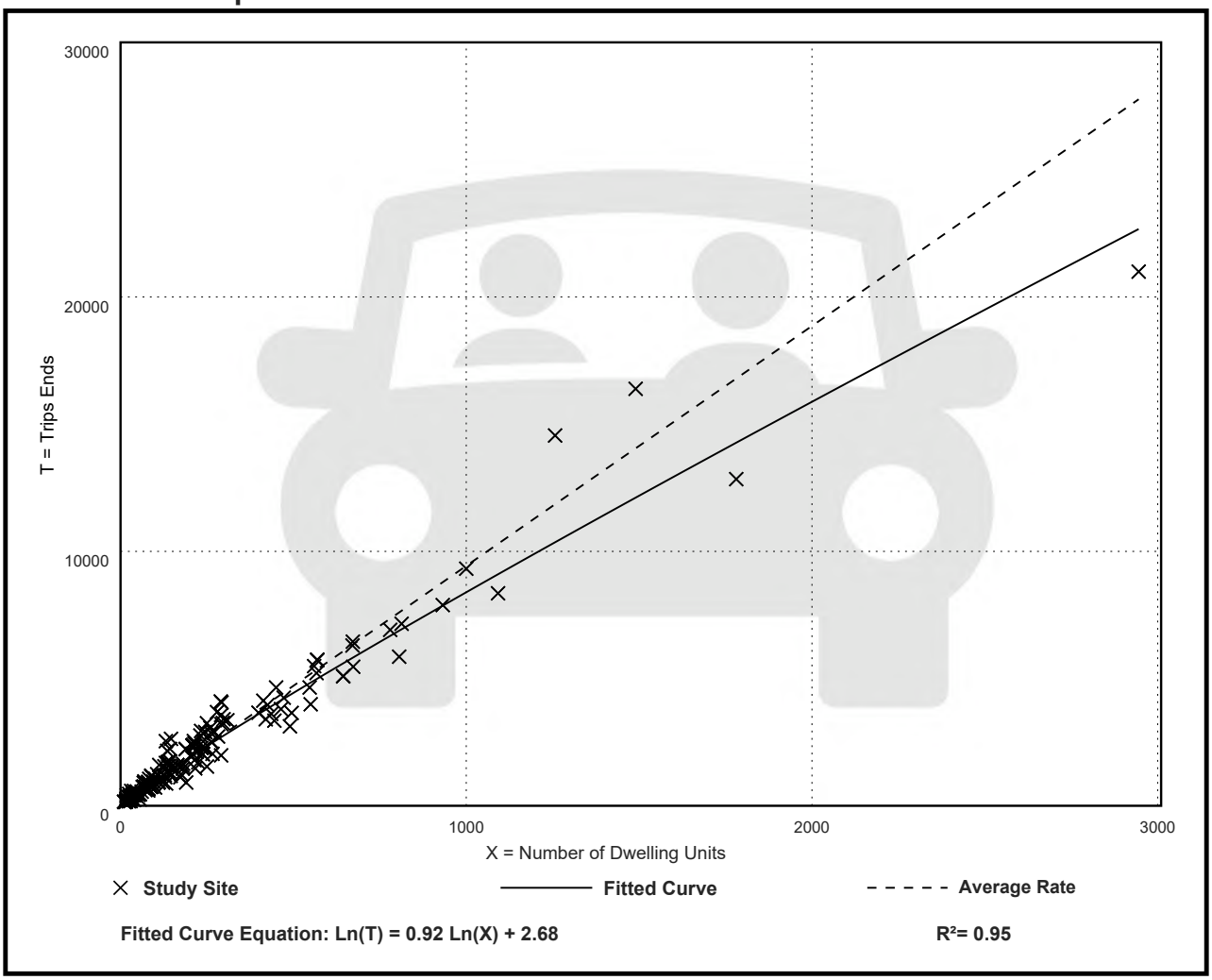
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 174
Avg. Num. of Dwelling Units: 246
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.43	4.45 - 22.61	2.13

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.92 Ln(X) + 2.68

R^2= 0.95

Land Use: 215
Single-Family Attached Housing

Description

Single-family attached housing includes any single-family housing unit that shares a wall with an adjoining dwelling unit, whether the walls are for living space, a vehicle garage, or storage space.

Additional Data

The database for this land use includes duplexes (defined as a single structure with two distinct dwelling units, typically joined side-by-side and each with at least one outside entrance) and townhouses/rowhouses (defined as a single structure with three or more distinct dwelling units, joined side-by-side in a row and each with an outside entrance).

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

The sites were surveyed in the 1980s, the 1990s, the 2000s, and the 2010s in British Columbia (CAN), California, Georgia, Illinois, Maryland, Massachusetts, Minnesota, New Jersey, Ontario (CAN), Oregon, Pennsylvania, South Dakota, Utah, Virginia, and Wisconsin.

Source Numbers

168, 204, 211, 237, 305, 306, 319, 321, 357, 390, 418, 525, 571, 583, 638, 735, 868, 869, 870, 896, 912, 959, 1009, 1046, 1056, 1058, 1077

Single-Family Attached Housing
(215)

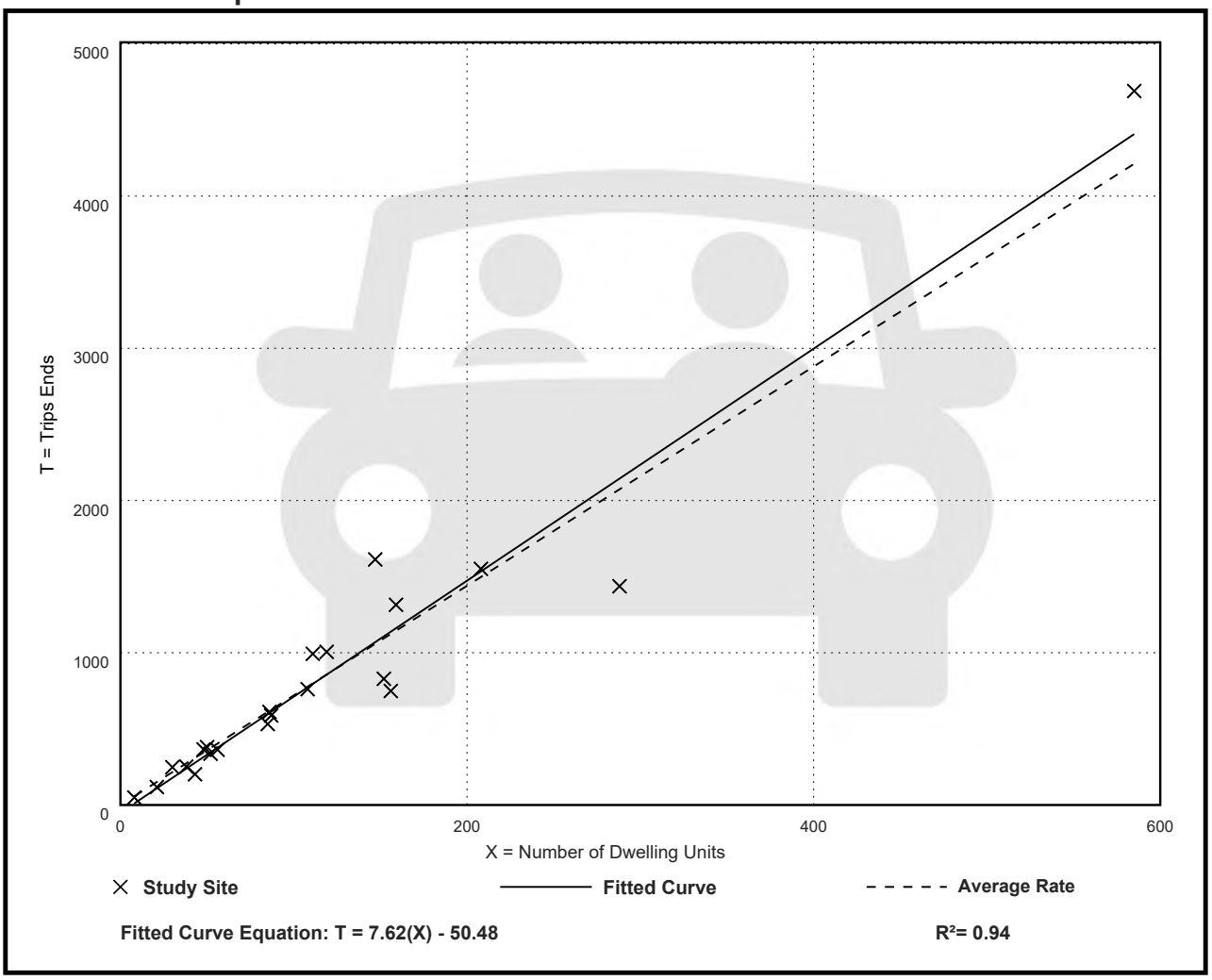
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 22
Avg. Num. of Dwelling Units: 120
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
7.20	4.70 - 10.97	1.61

Data Plot and Equation



Land Use: 220
Multifamily Housing (Low-Rise)

Description

Low-rise multifamily housing includes apartments, townhouses, and condominiums located within the same building with at least three other dwelling units and that have two or three floors (levels). Various configurations fit this description, including walkup apartment, mansion apartment, and stacked townhouse.

- A walkup apartment typically is two or three floors in height with dwelling units that are accessed by a single or multiple entrances with stairways and hallways.
- A mansion apartment is a single structure that contains several apartments within what appears to be a single-family dwelling unit.
- A fourplex is a single two-story structure with two matching dwelling units on the ground and second floors. Access to the individual units is typically internal to the structure and provided through a central entry and stairway.
- A stacked townhouse is designed to match the external appearance of a townhouse. But, unlike a townhouse dwelling unit that only shares walls with an adjoining unit, the stacked townhouse units share both floors and walls. Access to the individual units is typically internal to the structure and provided through a central entry and stairway.

Multifamily housing (mid-rise) (Land Use 221), multifamily housing (high-rise) (Land Use 222), affordable housing (Land Use 223), and off-campus student apartment (low-rise) (Land Use 225) are related land uses.

Land Use Subcategory

Data are presented for two subcategories for this land use: (1) not close to rail transit and (2) close to rail transit. A site is considered close to rail transit if the walking distance between the residential site entrance and the closest rail transit station entrance is ½ mile or less.

Additional Data

For the three sites for which both the number of residents and the number of occupied dwelling units were available, there were an average of 2.72 residents per occupied dwelling unit.

For the two sites for which the numbers of both total dwelling units and occupied dwelling units were available, an average of 96.2 percent of the total dwelling units were occupied.

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip

Multifamily Housing (Low-Rise)
Not Close to Rail Transit (220)

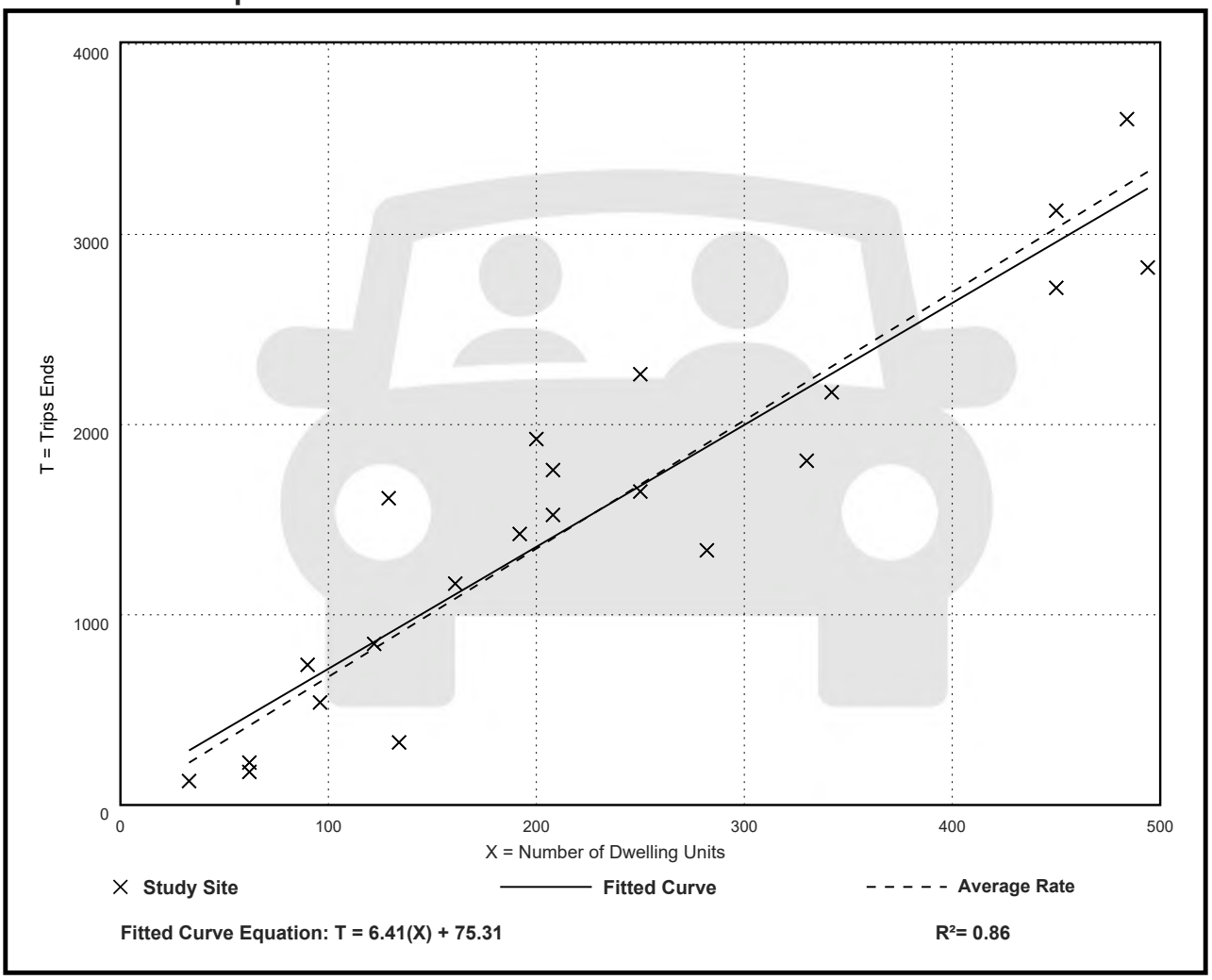
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 22
Avg. Num. of Dwelling Units: 229
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.74	2.46 - 12.50	1.79

Data Plot and Equation



Fitted Curve Equation: T = 6.41(X) + 75.31

R^2= 0.86

Land Use: 251
Senior Adult Housing—Single-Family

Description

Senior adult housing—single-family sites are independent living developments that are called various names including retirement communities, age-restricted housing, and active adult communities. The development has a specific age restriction for its residents, typically a minimum of 55 years of age for at least one resident of the household.

Residents in these communities are typically considered active and requiring little to no medical supervision. The percentage of retired residents varies by development. The development may include amenities such as a golf course, swimming pool, 24-hour security, transportation, and common recreational facilities. They generally lack centralized dining and on-site health facilities.

The dwelling units can be either detached or attached. The types of housing types represented by sites in the database include traditional single-family detached homes, patio homes, duplexes, and townhouses. Single-family attached housing includes any single-family housing unit that shares a wall with an adjoining dwelling unit, whether the walls are for living space, a vehicle garage, or storage space.

Senior adult housing—multifamily (Land Use 252), congregate care facility (Land Use 253), assisted living (Land Use 254), and continuing care retirement community (Land Use 255) are related land uses.

Additional Data

Caution should be used when applying trip rates for this land use as it may contain a wide variety of studies ranging from communities with very active, working residents to communities with older, retired residents. As more data become available, consideration will be given to future stratification of this land use.

Many factors affected the trip rates for detached senior adult housing. Factors such as the average age of residents, development location and size, affluence of residents, employment status, and vehicular access should be taken into consideration when conducting an analysis. Some developments were located within close proximity to medical facilities, restaurants, shopping centers, banks, and recreational activities.

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

For the six sites for which data were provided for both occupied dwelling units and total dwelling units, an average of 98 percent of the units were occupied.

Senior Adult Housing - Single-Family (251)

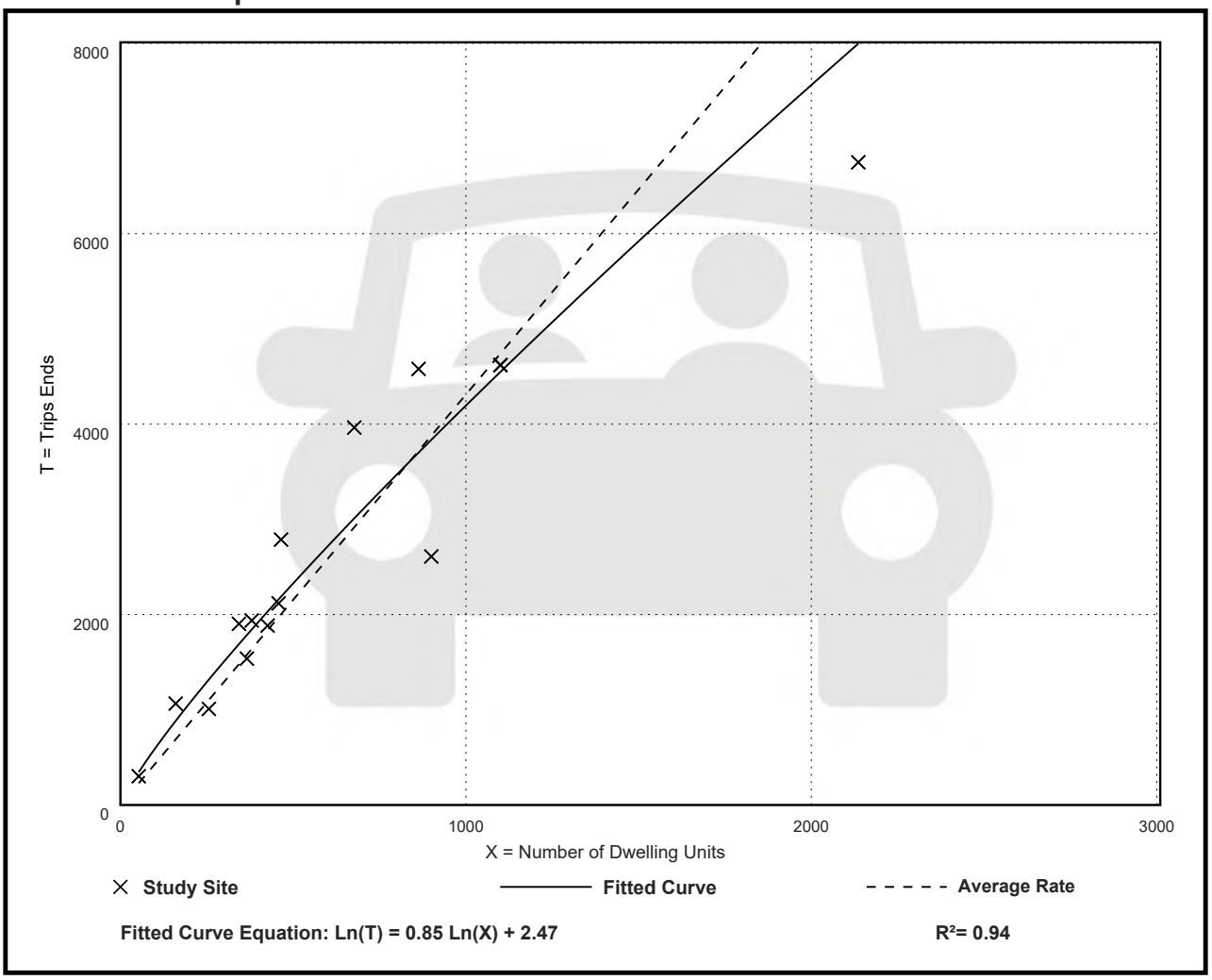
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 15
Avg. Num. of Dwelling Units: 646
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.31	2.90 - 6.66	1.07

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.85 Ln(X) + 2.47

R^2= 0.94

Land Use: 252
Senior Adult Housing—Multifamily

Description

Senior adult housing–multifamily sites are independent living developments that are called various names including retirement communities, age-restricted housing, and active adult communities. The development has a specific age restriction for its residents, typically a minimum of 55 years of age for at least one resident of the household.

Residents in these communities are typically considered active and requiring little to no medical supervision. The percentage of retired residents varies by development. The development may include amenities such as a golf course, swimming pool, 24-hour security, transportation, and common recreational facilities. They generally lack centralized dining and on-site health facilities.

The dwelling units share both floors and walls with other units in the residential building. Senior adult housing—single-family (Land Use 251), congregate care facility (Land Use 253), assisted living (Land Use 254), and continuing care retirement community (Land Use 255) are related land uses.

Additional Data

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

The sites were surveyed in the 1980s, the 1990s, and the 2000s in Alberta (CAN), California, Maryland, New Hampshire, New Jersey, Ontario (CAN), and Pennsylvania.

Source Numbers

237, 272, 576, 703, 734, 970, 1060

Senior Adult Housing - Multifamily
(252)

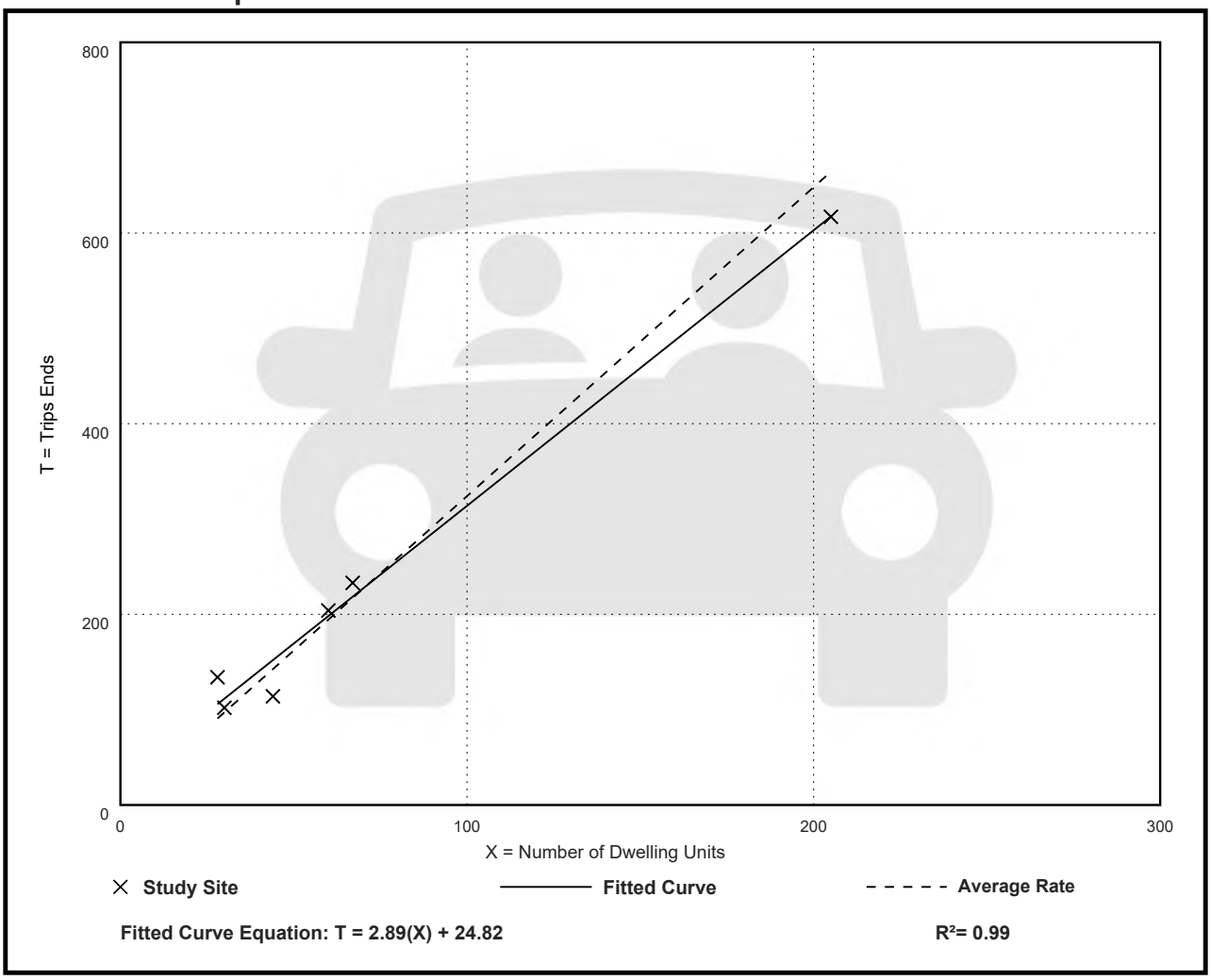
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 6
Avg. Num. of Dwelling Units: 72
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
3.24	2.59 - 4.79	0.53

Data Plot and Equation



Fitted Curve Equation: T = 2.89(X) + 24.82

R^2= 0.99

Appendix 6
Street System Cost Summary

Road Price List

Description	Price	Units
Right Of Way	$200,000.00	Acre
Pavement & UBC	$4.50	S.F.
Granular Fill	$40.00	C.Y.
Clear & Grub	$3.50	C.Y.
Chip Seal	$2.00	S.Y.
Curb & Gutter	$105.00	L.F.
2" Overlay Existing Asphalt	$1.50	S.F.
Sidewalk one side of street	$50.00	LF
Design, CM, Insp	15%	
Contingency & Util Conflicts	20%	

Table 4-7: Cost Summary of Recommended Street Improvements

NORTH VILLAGE STREET CAPITAL IMPROVEMENTS

ULT	CIP#	IMPROVEMENT DESCRIPTION	LENGTH / COST	LUMP SUM	LOCAL	MINOR COLLECTOR	MAJOR COLLECTOR	WIDTH ROW	WIDTH ASPHALT	ROW	PAVEMENT & UBC	GRANULAR FILL	CLEAR & GRUB	CURB & GUTTER	SIDEWALK	Chip Seal	OVERLAY EXIST	WIDENING	ENG CM INSP	COST
			ft	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	
	T-001	Road F - East of SR 32 to Local Road A	1,200				X	85	50	X	X	X	X	X	X				X	$1,602,084
	T-002	Road F - Road A to Moulton Ln	2,800				X	85	50	X	X	X	X	X	X				X	$3,738,197
	T-003	Road F - Moulton Ln to Road B	1,800				X	85	50	X	X	X	X	X	X				X	$2,403,126
	T-004	Road F - Road B to University Ave	1,000				X	85	50	X	X	X	X	X	X				X	$1,335,070
	T-005	Moulton Ln (shifted north) - US 40 to Road F	600				X	85	50	X	X	X	X	X	X				X	$801,042
	T-006*	Local Road A - Road F to Road B	4,000		X			62	32	X	X	X	X	X	X				X	$4,143,721
	T-007*	Local Road A - Road B to University Ave	1,700		X			62	32	X	X	X	X	X	X				X	$1,761,081
	T-008*	Road B - Road F to Road A	1,500			X		68	38	X	X	X	X	X	X				X	$1,687,625
	T-009*	University Ave - US 40 to Road F	1,200				X	95	60	X	X	X	X	X	X			X	X	$2,128,120
	T-010*	University Ave - Road F to Road A	1,400				X	85	50	X	X	X	X	X	X				X	$1,869,098
	T-011*	University Ave - Road A to Commons Blvd	1,300				X	85	50	X	X	X	X	X	X				X	$1,735,591
	T-012	Commons Blvd - University Ave to Road E	1,200				X	85	50	X	X	X	X	X	X				X	$1,602,084
	T-013	Commons Blvd- Road E to Valley Hills Blvd	1,100				X	85	50	X	X	X	X	X	X				X	$1,468,577
	T-014*	Commons Blvd - Valley Hills Blvd to Road D	600				X	85	50	X	X	X	X	X	X				X	$801,042
	T-015	Commons Blvd - US 40 to Road D	800				X	95	60	X	X	X	X	X	X			X	X	$1,418,747
	T-016*	Road C - University Ave to College Way	1,000			X		68	38	X	X	X	X	X	X				X	$1,125,083
	T-017	College Way - US 40 to Road C	500			X		68	38	X	X	X	X	X	X			X	X	$613,678
	T-018	College Way - Road C to Road D	700			X		68	38	X	X	X	X	X	X				X	$787,558
	T-019*	College Way - Road D to Collage PL	400			X		68	38	X	X	X	X	X	X				X	$450,033
	T-020	Road E - College PL to Commons Blvd	1400			X		68	38	X	X	X	X	X	X				X	$1,575,117
	T-021	Road D - College Way to Commons Blvd	1,600			X		68	38	X	X	X	X	X	X				X	$1,800,134
	T-022	Coyote View Dr - Commons Blvd to Fitzgerald Dr	3,800			X		68	38	X	X	X	X	X	X				X	$4,275,317
	T-023	Coyote View Dr - Fitzgerald Dr to Coyote Cyn Pkwy	1,700			X		68	38	X	X	X	X	X	X				X	$1,912,642
	T-024	Coyote Cyn Pkwy - Coyote View Dr to Timp Canal	1,800			X		68	38	X	X	X	X	X	X				X	$2,025,150
	T-025	Valley Hills Blvd - Commons Blvd to Fitzgerald Dr	1,800			X		68	38	X	X	X	X	X	X				X	$2,025,150
	T-026	Fitzgerald Dr - US 40 to Ostler Peak Rd	800			X		68	38	X	X	X	X	X	X				X	$900,067
	T-027*	Fitzgerald Dr - Ostler Peak Rd to Valley Hills Blvd	500			X		68	38	X	X	X	X	X	X				X	$562,542
	T-028*	Fitzgerald Dr - Valley Hills Blvd to Coyote View Dr	2,300			X		68	38	X	X	X	X	X	X				X	$2,587,692
	T-029	Ostler Peak Rd - Fitzgerald Dr to Coyote Cyn Pkwy	2,200		X			62	32	X	X	X	X	X	X				X	$2,279,047
	T-030	Valley Hills Blvd - Fitzgerald Dr to Coyote Cyn Pkwy	2,300			X		68	38	X	X	X	X	X	X				X	$2,587,692
	T-031	Coyote Cyn Pkwy - US 40 to Ostler Peak Rd	1,100				X	85	50	X	X	X	X	X	X			X	X	$1,693,579
	T-032*	Coyote Cyn Pkwy - Ostler Peak Rd to Valley Hills B	900				X	85	50	X	X	X	X	X	X			X	X	$1,385,655
	T-033*	Coyote Cyn Pkwy - Valley Hills Blvd to Timp Canal	1,700				X	85	50	X	X	X	X	X	X				X	$2,269,619
	T-034	Intersection 1 - UDOT Traffic Signal (SR 32)	$500,000	X															X	$690,000
	T-035	Intersection 3 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-036	Intersection 5 - Single Lane Roundabout	$750,000	X															X	$1,035,000
	T-037	Intersection 10 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-038	Intersection 8 - Single Lane Roundabout (2-Way St	$750,000	X															X	$1,035,000
	T-039	Intersection 9 - Multi Lane Roundabout	$750,000	X															X	$1,035,000
	T-040	Intersection 13 - Single Lane Roundabout (2-Way S	$1,000,000	X															X	$1,380,000
	T-041	Intersection 16 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-042	Intersection 17 - Multi Lane Roundabout	$1,000,000	X															X	$1,380,000
	T-043	Intersection 18 - Multi Lane Roundabout	$1,000,000	X															X	$1,380,000
	T-044	Intersection 23 - UDOT Traffic Signal (US 40)	$500,000	X															X	$690,000
	T-045	North Village Master Plan Update (5 yrs x 4 Times)	$160,000	X																$192,000
		TOTAL STREETS:																**TOTAL:**		**$70,237,963**

NOTES:

- Road Widening assumes existing road asphalt is 26' wide. Upsizing is difference between existing and master planned asphalt width; ie. Local 32', Minor Collector 38', Major Collector 50', Minor Arterial 60'.
- UDOT Intersection Improvements are expected to have a cost of $0 incurred by Heber City.
- Percent paid by developers for road widening costs on existing roads: Major/Minor Locals 100%, Minor Collectors 83%, Major Collectors 75%.
- Percent paid by developers for cost to construct new roads: see above notes.
- Curb and gutter price storm drain system price of $105 per foot is for one side of the road. The formula multipies by 2 to cover boths side of the road and all of the storm drain system.
- Prices do not include bridges, blasting, retaining walls, relocation of utilities, or guardrails.
- Prices inlcudes oversizing of storm pipes and facilities due to road widing from Major Local. And also lenghting of culverts at drainage crossings.

* Includes a bridge over a canal.

Appendix 7
Storm Water Design Water Manual

HEBER CITY

HEART OF THE WASATCH BACK

HEBER CITY STORM WATER DESIGN MANUAL

Heber City Engineering

DRAFT

SEPTEMBER 8, 2022

HEBER CITY
75 N Main Street
Heber City, UT 84032

Contents

Introduction 1
Purpose of document 1
Definitions 1
Approval Procedure 2
Preliminary Drainage Plan and Report 2
Final Drainage Plan and Report 2
Design Standards and Analysis Methods 3
Design Storms for Conveyance 3
Storage Facilities 4
Storm Drain System Hydraulic Requirements 5
Channel Hydraulic Requirements 5
Above Ground Storage Basins (Ponds) 5
Culverts 6
Roadway Drainage 6
Rainfall Runoff Computation Methods 7
Post Construction Peak Discharge 8
Infiltration 9
Low Impact Development 9
Vegetated Swales 10
Dry Swales 10
Wet Swales 10
Infiltration Basin/Galleries 11
Rain Gardens 11
Water Quality 12
Pre-treatment and Treatment Systems 12
Water Quality Control Measures 15
Source Protection 15
Natural Channels 16
Flood and Debris Flow Hazards 16
FEMA Flood Analysis 16
Debris-Flow Flood Hazard Analysis 16
Appendices 19

Introduction

Purpose of document

The purpose of this document is to establish design standards and guidelines for storm drainage infrastructure within Heber City. This document also promotes uniformity among development design submittals and drainage reports.

The design criteria in this document are for use on public and private projects within the city. There are other adopted City documents that also reference requirements related to storm drain systems within the city. These documents include the Heber City Standard Specifications and Drawings, the Heber City Master Plans, and the Heber City Municipal Code. This document is designed to work in collaboration with these other stated references, however, in the case of discrepancies the more stringent standard will apply. All requirements and the intent of design requirements in this document shall be met unless otherwise approved by the City Engineer.

Definitions

cfs	*Cubic feet per second (449 gallons per minute)*
Ac-Ft	*Acre-foot (volume of water required to cover an acre of land to a depth of one foot)*
Detention	*Short term storage of runoff provided by a pond or similar facility. An outlet is provided that allows water to be released from the facility at a predetermined rate.*
LID	*Low Impact Development is an approach to improving water quality by reducing the amount of storm runoff generated by a project and relying on infiltration or evaporation to handle runoff where it is generated.*
Retention	*Long term storage of storm water provided by a pond or similar facility that does not allow water to be discharged. Water will stay in a retention pond after a storm event until it either evaporates or infiltrates into the bottom of the pond.*

DRAFT

Approval Procedure

Preliminary Drainage Plan and Report

i. A preliminary drainage plan and report are required for all site plan and subdivision developments within the city. The preliminary drainage plan must include the following as applicable:
    1. Existing topography (2-foot contours or finer) extending at least 100 feet beyond the site
    2. Existing drainage infrastructure and features
    3. Existing drainage and gravity irrigation channel/canal features
    4. Watershed delineations and existing drainage patterns/flow paths
    5. Proposed drainage infrastructure and features (onsite and offsite)
    6. Proposed drainage patterns/flow paths
ii. The preliminary drainage report must include the following as applicable:
    1. Introduction
    2. Project Scope
    3. Project Location
    4. Description of Existing Conditions
    5. Drainage Design Criteria
    6. Off-Site Watershed Drainage and Hydrology
        a. Preliminary Upstream/Downstream Flood Analysis
        b. Preliminary Hazards & Debris-Flow Analysis
    7. On-Site Area Drainage and Hydrology and Hydraulics
    8. LID features
    9. Detention and/or Retention Facilities
    10. Water Quality Features (e.g., LID, HDS, pretreatment etc.)
    11. Major Stream Crossings
    12. Non-pressurized Irrigation Systems

Final Drainage Plan and Report

iii. Final drainage plans and report are required for all site plan and subdivision developments within the City shall be submitted after acceptance/approval of the preliminary submittal. The final drainage report shall be submitted for review prior to final site plan or subdivision approval.
iv. Final Drainage Plans must include the following as applicable:
    1. Existing and proposed topography (2-foot contours or finer) extending at least 100 feet beyond the site
    2. Existing drainage infrastructure and features
        a. Onsite features (channels, flow control, etc.)
        b. Offsite features (debris basins, etc.)
    3. Existing drainage and gravity irrigation channel/canal features
    4. Watershed delineations and existing drainage patterns/flow paths
    5. Location of all proposed drainage features
        a. Onsite features (channels, flow control, etc.)
        b. Offsite features (debris basins, etc.)

6. Proposed drainage patterns/flow paths
7. Proposed drainage details
8. Improvements to city facilities
9. LID, water quality and retention features

v. Final Drainage Report must include as applicable:
1. Introduction
2. Project Scope
3. Project Location
4. Detailed Description of Existing Conditions
5. Drainage Design Criteria
6. Off-Site Drainage and Hydrology with Final Calculations
    a. Final Upstream/Downstream Flood Analysis
    b. Final Hazards & Debris-Flow Analysis
    c. Recommended Mitigation
7. On-Site Drainage Hydrology and Hydraulics with Final Calculations
8. Description of LID Measures
    a. Justification for products selected and why they are most appropriate
    b. Compliance with on-site retention rules
9. Detailed Description of Detention and/or Retention Facilities
10. Major Stream Crossing
11. Non-pressured Irrigation Systems
12. Permanent Erosion Control Features
13. Water Quality Features (e.g., LID, HDS, pretreatment etc.)
14. Storm Drain System Calculations

All plans and reports are subject to review and approved by Provo River Watershed Council. See Appendix A for list of resources for drainage design in Heber City.

Design Standards and Analysis Methods

These standards apply to all developments within Heber City including the North Village area or other areas that may annex into the City in the future. Heber City may establish additional storm drain design criteria for certain development areas through a new Storm Drain Master Plan and/or Master Plan update. All developments shall comply with the City Storm Drain Master Plan that is applicable for the respective development.

Design Storms for Conveyance

New developments within Heber City must have an initial and a major storm drain system for storm water conveyance. The initial system's purpose is to reduce the frequency of street flooding, reduce maintenance costs, and provide protection against regularly recurring damage from storm runoff. The initial conveyance system must handle the 10-year storm event at a duration equal to or less than the time of concentration (T_c), and typically consists of pipe, storm drain inlets, curb and gutter, or drainage swales that convey the storm water.

The purpose of the major conveyance system is to avoid major property damage or loss of life during flood level runoff conditions. The major system is comprised of the initial conveyance system elements but also includes the entire roadway cross section, including park strip and sidewalk, or other safe surface routes. The major system must protect against flooding during the 100-year storm event at a duration equal to or less than the T_c.

Every effort shall be made to keep the major system above ground. But, where that is impractical, the City Engineer may approve the major system to be underground if it is designed for it from the top of the catchment. “Funneling” at the bottom of a catchment is not allowed. The following figure details how the initial and major systems must function.

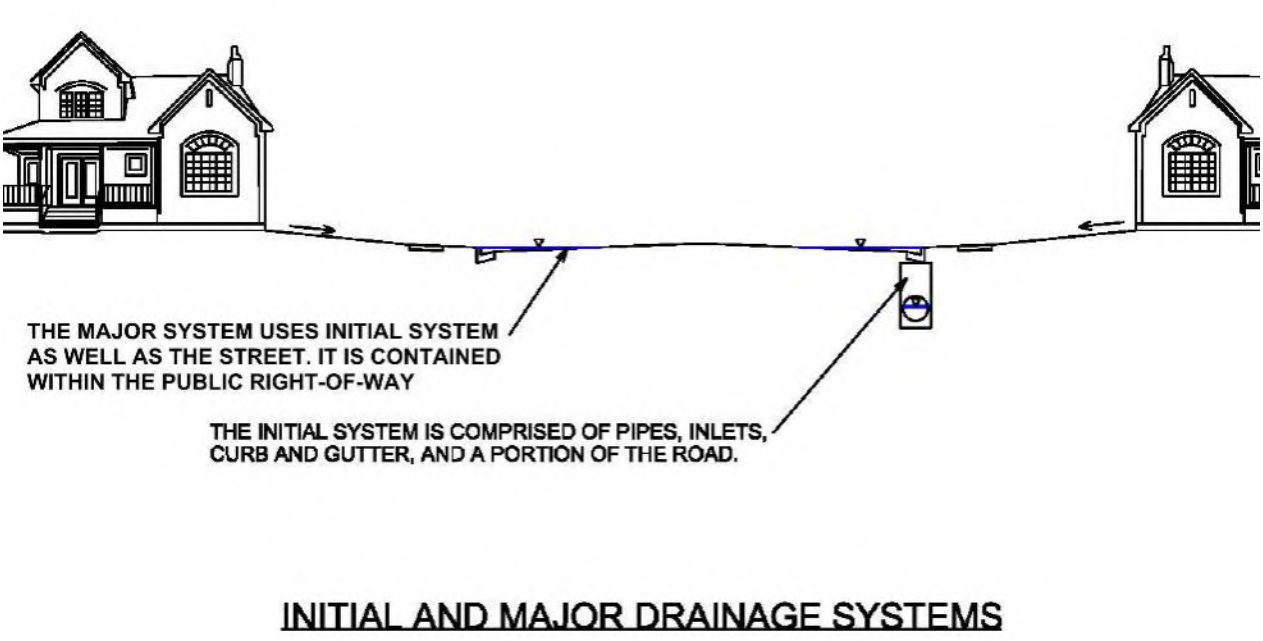


Figure 1. Initial and Major Drainage Systems

Directly connected impervious areas should be independent watershed basins and should not be combined and averaged with pervious areas.

Storage Facilities

Storm drain storage facilities are required for flood control and water quality purposes. Storage facilities may be above ground basins/ponds or below ground storage systems. Detention storage facilities require an approved suitable discharge location approved by the City Engineer. Retention facilities are required when no suitable discharge location is available. Detention facilities must be designed to store and detain the 25-year event with a maximum release rate of the lesser of 0.1 cfs/acre or historic flows in the 2-year, 10-year and 25-year events. See the Post Construction Peak Discharge section for more detailed requirements. Retention storage facilities must provide retention volume for the 100-year, 24-hour event. Infiltration may be considered as outflow when sizing retention facilities. See the section on

Infiltration in this document for details regarding infiltration requirements. However, if infiltration is utilized for facility sizing design, shorter storm durations with higher intensities must be checked (i.e., rational spreadsheet), and the controlling or largest volume, minus the infiltration, shall be used to size the storage facility. Therefore, the 24-hour storm may not result in the largest storage volume. When utilizing the SCS Type II 24-hour storm for sizing storage facilities with infiltration, the storm distribution must provide a peak intensity where the majority of the rainfall occurs during a shorter period of time.

Storm Drain System Hydraulic Requirements

Pipe systems used for conveyance must be designed such that they flow unpressurized during the required design event. Minimum pipe diameter for public storm drain pipes within City right-of-way is 18 inches but may be reduced to 15 inches for pipes from a single inlet box. Private storm drain pipe may be reduced to 10 inches but must still adhere to conveyance design storm requirements. Pipe material must adhere to Heber City Standard Specifications and Drawings. Junction boxes or manholes should be placed such that the maximum pipe length between two structures does not exceed 400 feet.

Apply an inlet clogging factor of 30% for inlets on grade and 50% for inlets in sags.

The minimum pipe slopes shall be pursuant to HEC 22 Table 7-7. The n-values shall be 0.012 for plastic pipe and 0.013 for concrete pipe.

On steeper slopes, provide a sufficient number of inlets to reduce inlet bypass to less than 0.2 cfs and to reduce risk of water sweeping pedestrians off their feet.

Design storm drain system per HEC-22.

Channel Hydraulic Requirements

Open channels that are part of the initial conveyance system shall be designed to convey the 10-year flow while maintaining one-foot of freeboard. Channels that are located within a FEMA Special Flood Hazard Area, open channels that are the major conveyance system, and natural drainage channels shall be designed to convey the 100-year flow with one foot of freeboard. All channel sections must be adequately designed, detailed, and constructed, pursuant to the latest edition of HEC 15, to prevent erosion of the channel bed and banks.

Above Ground Storage Basins (Ponds)

Above ground storage basins (ponds) shall be designed as attractive and usable spaces. Water depth should be five feet or less where feasible, appropriate landscaping shall be incorporated, and include elements that eliminate standing water and low flow impacts. Detention ponds shall include a low-flow surface channel, or underdrain that is sized for the 2-year storm event.

The required freeboard for detention basins is two feet in areas where any portion of the pond is constructed above existing ground and one foot when the pond is excavated in existing ground.

Basin side slopes should be 5H:1V or flatter on two or more sides, 4H:1V or flatter slopes on remaining sides, with a minimum 1% bottom slope. If the natural existing slope is greater than 8% then basin side slopes may be increased to 3H:1V. A suitable location for ingress and egress shall be incorporated for ponds deeper than three feet, and this must include an access at least 15-feet wide at less than 15% grade. A minimum five-foot buffer between any pond grading and the property lines shall be provided.

Landscaping: Grass or other suitable landscaping materials should be used, and turf irrigation systems shall be installed for ponds that will be maintained by City personnel, unless a low-maintenance landscaping alternative is approved. Irrigating methods and practices must be accounted for in the hydrologic and infiltration calculations when designing and sizing ponds. Developers will be required to escrow funds to landscape ponds when located on private lots for future reimbursement to the owner who completes the landscaping at a future time. Developers will not use landscaping that may hinder infiltration if it is used in the sizing of the pond or required for Municipal Separate Storm Sewer (MS4) compliance. See infiltration section for more information on infiltration and landscaping requirements.

Easements: If basins are placed on private property, a minimum 20-foot easement for all underground lineal pipeline facilities and access to maintain ponds must be provided. Additionally, an easement must be provided over the pond area and a minimum of five feet beyond the pond top of slope perimeter. The easement shall be ten feet beyond the pond perimeter when an access along the pond edge is required. Pond easements shown on subdivision plats shall have restrictive language labeled with dimensions to facilitate locating in the field.

Basins shall be designed with provisions for an emergency overflow that will avoid flood damage to surrounding properties in the event of a storm exceeding the design capacity of the basin.

Retention basins shall be designed with mechanisms to ensure that the basin will completely drain within 48 hours after the 24-hour event with additional precipitation. (Verify a 72-hour storm will not overtop the basin). See the section on Infiltration in this document for details regarding infiltration requirements.

Basin inlets and outlets shall have trash racks or grates installed. A storm water pretreatment device, approved by the City, shall be installed upstream of the pond or sump inlets. See the Water Quality section of this report for requirements.

Culverts

Culverts that convey off-site flows through a project or beneath a road shall be designed for the 100-year event. Culverts shall be designed so the headwater elevation does not exceed 1.5 times the culvert diameter, or one foot below the elevation where water spills over the road or out of the channel. Concrete box culverts shall have a minimum 5-feet height from floor to ceiling, and multi-barrel culverts may not be used where high amounts of debris is expected. If multi-barrel culverts are used in other locations, designers must consider elevations of roads, buildings, driveways, and other features to prevent adverse impacts. Normal depth equations (Manning's Equations) cannot be used for culvert analysis. Inlet and outlet control shall be checked, and culvert hydraulic calculations provided.

Roadway Drainage

Inlets within roadways should be placed to control spread, or the amount of water flowing along the side of the road and in the gutter. Allowable spread is determined by the roadway classification as follows:

Table 1. Design Spread for Roadways

Design Frequency and Spread		
Roadway Classification	**Design Frequency**	**Design Spread**
Highway or Major Collector > 35 MPH	10-Year @ T_c	Shoulder (Outside of travel lane)
Highway or Major Collector ≤ 35 MPH	10-Year @ T_c	Shoulder + three feet
Local Street	10-Year @ T_c	½ Driving Lane

Inlets should also be placed upstream of intersections and pedestrian ramps to reduce bypass flows. Spread calculations shall be checked using HEC 22, Appendix A, Chart 1B.

Rainfall Runoff Computation Methods

Precipitation data obtained from the NOAA ATLAS 14 Point Precipitation Frequency website including intensity and depth data for Heber City is contained in Appendix B. This information shall be used for all development within Heber City.

Several hydrologic methods may be applicable depending on what type of analysis is required. The Rational Method is the most common method and may be used for sizing pipes, checking inlet spread and estimating peak flow rates for areas up to 100 acres.

Rational Method runoff coefficients are shown in Table 2. The runoff coefficients listed in Table 2 are the minimum values to be used in Heber City. Any runoff coefficients for other characteristics should be adjusted to account for the 100-year rainfall.

Table 2. Rational Runoff Coefficients

Surface or Cover Type *	**Runoff Coefficient (C)**
Asphalt or Concrete Pavement	0.90 (asphalt) 0.95 (concrete)
Roofs of Buildings (type dependent)	0.90 (asphalt shingles) 0.95 (steel)
Grass-covered Sandy Soils, Slopes 2% or less	0.13
Grass-covered Sandy Soils, Slopes > 2%	0.20
Grass-covered Clay Soils, Slopes 2% or less	0.22
Grass-covered Clay Soils, Slopes > 2%	0.49

* Surfaces not addressed in this table shall be approved by the City Engineer.

For storm analyses that require developing a volume or routing a volume of runoff, a hydrograph method should be used. Multiple hydrographs were developed by the Soil Conservation Service (SCS), now known as Natural Resources Conservation Service (NRCS). The SCS Type II 24-hour storm distribution should be used for estimating the precipitation for developments within Heber City.

The SCS method uses the Curve Number Method for determining rainfall runoff. Curve Numbers are determined by using a land cover type in conjunction with a hydrologic soil group. Land cover information can be obtained by means of aerial topography or GIS data. Hydrologic soil group information may be obtained from NRCS's Web Soil Survey website. The land cover and hydrologic soil group information are used to select an appropriate curve number using the manual titled *TR-55 Urban Hydrology for Small Watersheds*. TR-55 worksheets and calculation methods are provided in Appendix G and shall be utilized for developments that use the SCS method to estimate run-off. Typical CN values are included in Appendix C. Engineering judgement should be used when selecting curve numbers. Part

630 of the National Engineering Handbook says, “As a result of construction and other disturbances, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the hydrologic properties of the disturbed soil. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group.” Site specific factors such as terrain, potential precipitation on frozen ground, future conditions and other factors should be considered when selecting curve numbers. The SCS method shall only be used for estimating the run-off for development which are greater than 10 acres.

The Federal Aviation Administration (FAA) Method for estimating detention or retention volumes may also be used for approximating storage facility volume requirements for developments. It is outdated because it does not model the release rate correctly. However, with the Guo Averaging Parameter, it is valid and can be used. However, it is not applicable to in-series (cascading) ponds. This method is applicable for developments less than 100 acres, and the SCS method is required for developments larger than 100 acres. The FAA Method uses a spreadsheet to evaluate several storm durations for a given return period for either the 100-year storm (retention) or 25-year storm (detention). The total inflow volume for a storm duration is developed by multiplying the peak flow rate by the storm duration. The volume out is developed by utilizing a controlled discharge amount (discharge with detention only), and/or exfiltration from the detention pond when conditions permit. The required volume is equal to the inflow volume minus the outflow volume. This is evaluated for all storm durations to determine which storm duration provides the maximum required volume. Developments that use the FAA Method for estimating storage facility volumes shall use the spreadsheets provided by the City including the Guo Averaging Parameter when off-site discharge is utilized. An example is shown in Appendix I, or other approved spreadsheet formats.

Several methods for estimating time of concentration exist. They were each developed for specific parameters such as watershed size, slope, etc. Time of concentration methods used should be applicable to the areas in which they are being analyzed. The minimum time of concentration value should be 5 minutes.

For all software models, input and output data shall be provided so that it can be reviewed by the City. A copy of the model file shall also be provided to the City for review. Models must be provided to the City in Civil 3D Storm and Sanitary Analysis. City may consider other software models based on prior approval from the City Engineer.

Post Construction Peak Discharge

Heber City has adopted a 0.10 cfs/acre maximum release standard for undeveloped areas, i.e., areas outside Central Heber. This rate is assumed to be the historical undeveloped flow. For example, a 10-acre housing development would be able to have a post-development discharge rate of 1.0 cfs (10 acres x 0.10 cfs/acre) provided there is a suitable point to discharge to. If the historic flow is found to be less than the 0.1 cfs/acre, this shall be used as the maximum allowed post-development discharge. Moreover, if the downstream system does not have capacity for the 0.1 cfs/acre discharge rate, the available capacity will become the controlling factor. To ensure that flow from new developments do not exceed 0.10 cfs/acre, detention facilities with controlled discharge are required. In cases where there is no suitable point to discharge to, retention facilities are required. See storage facilities section for more information.

Infiltration

Infiltration of treated storm water into the ground is encouraged. Detention and retention basin volumes may be sized by considering infiltration as an outflow component. Prior to assuming infiltration is a viable option, infiltration tests shall be conducted by a professional geotechnical engineer, geologist, or soil scientist licensed in Utah that determines the infiltration rate and demonstrates that the proposed soil profile is suitable for infiltration and will readily accept the water. Infiltration tests shall be performed using the double ring infiltrometer test in accordance with ASTM D 3385, and shall be performed at the location of where the result will be applied and at the elevation of the bottom of the facility where infiltration will occur. A minimum of two tests shall be performed with a minimum of one test per 10,000 square feet of the infiltration area.

Groundwater elevations shall be determined. Potential ground water level fluctuations shall be considered, and the lowest elevation of any detention basin should be at least two feet higher than the highest seasonal groundwater elevation. All design infiltration rates shall have a safety factor of two (2) or higher applied to the actual rate measured by the official infiltration test.

Only the plan view area at the bottom of the storage facility may be used as an infiltration surface in infiltration calculations unless stage-volume-discharge curves are created and used. Infiltration must not be considered as an outflow prior to the storm water entering the pond, as this could create negative storage volume.

Infiltration rates shall only be applied to the same soil that has been tested. If topsoil or other less permeable soil is added to a storage facility where percolation is being applied, the infiltration rate used in the design shall match rate of the less permeable soil. Alternatively, a permeable layer of gravel shall be used in the entire infiltration area.

An infiltration rate map is included in Appendix D. It is included to provide general infiltration information but shall not replace actual field tests.

Comply with all State groundwater protection regulations, guidelines and permits such as those associated with infiltration, infiltration wells, Class V injection wells and any others applicable to the site.

Long-Term Storm Drain Facility Maintenance

All public storm drain facilities will be maintained by Heber City unless otherwise specified in the development agreements. Developers, property owners, or their representatives such as a Homeowners Association, shall enter into a post-construction storm water management agreement with the City for all privately owned storm drain facilities, and/or publicly owned storm drain facilities that convey storm water from private roads and facilities. See Appendix J for template agreements.

Low Impact Development

Low Impact Development (LID) is a method of reducing storm runoff by capturing, treating, and retaining it on a very local level within each individual development. Although Heber City is not currently on the Utah MS4 list, it is anticipated to become an MS4 community in the future. LID is required by the Utah Department of Environmental Quality as part of an MS4 Program. To prepare for future compliance with the MS4 storm water discharge program and to reduce post-development storm water run-off in general, developments within Heber City must retain and treat the 80th percentile rainfall

event as part of LID requirements. LID measures can also help achieve the onsite retention and treatment requirements. The 80th percentile depth for Heber City has been determined to be 0.47 inches. See Appendix E for this calculation. The Reese method, as shown in Appendix E, shall be used to calculate the volumetric runoff coefficient used for determining the 80th percentile volume. For developments larger than 10 acres use SCS Method to determine 80th percentile volume.

Localized LID methods are encouraged, however, the 80th percentile volume may be incorporated into larger detention or retention storage facilities if those facilities are located on site within the development area, or adjacent to, and if approved by the City Engineer.

Several typical LID measures are described in the following paragraphs. Portions of the LID descriptions have been taken from the Utah City Engineers Association (UCEA) and Utah DEQ LID Manual. See Appendix F for LID general details. The following LID descriptions are the approved LID measures to be used in Heber City. Any other proposed LID measures shall be approved by the City Engineer on a case-by-case basis. Please see the DEQ "Guide to Low Impact Development with Utah" for additional LID design guidelines and design flow-chart requirements.

Vegetated Swales

Vegetated swales may be considered dry or wet swales, and serve as a vegetative buffer between paved areas and storm drain facilities. The main advantages of vegetated swales are the degree of velocity reduction, detention, infiltration, and reduction of hard surface runoff. Storm runoff flows through the swale, where sediment and pollutants may settle out prior to entering downstream drainage facilities. A curb cut is one means of directing flow into swales where changes in elevation are limited.

Swales are often an attractive BMP solution because they can take advantage of already planned park strips. It should be noted that studies have shown that vegetated swales have a moderate ability to remove pollutants from storm water.

Dry Swales

A dry swale is a shallow, gently sloping drainage channel with broad, vegetated, side slopes. Dry swales provide temporary storage, filtration, and infiltration of storm runoff. A dry swale is versatile because it requires a relatively small area. Reduced channel velocities increase infiltration and water quality treatment and may reduce peak runoff. Channel vegetation can include turf, meadow grass, shrubs, and in limited quantities, small trees. Dry swales must be located above the water table to provide drainage. Dry swales are only allowed when groundwater is equal to or greater than 2-feet below the swale bottom elevation. When infiltrations rates are greater than 6.0 in/hour, dry swales shall either be designed as a biofilter for treatment of storm water or be preceded by an approved pre-treatment system. See the Water Quality section in this report for requirements. Retention LIDs shall provide treatment through settling, decreased flow rate, and bioretention with a designed release time.

Wet Swales

Wet swales are a type of filtration BMP and occur when the water table is located close to the surface. Wet swales act as a long and linear shallow treatment system. Like dry swales, check dams can be used as needed to create cells and contain the entire water quality treatment volume. Cells may be planted with emergent wetland plant species to improve pollutant removal. Wet swales, at a minimum, shall be preceded by a pre-treatment device to capture and remove pollutants and coarse sediment particles, see the Water Quality section below.

Infiltration Basin/Galleries

An infiltration basin is essentially a detention basin that is constructed such that storm water can exit the basin by means of infiltration into the surrounding ground. These include underground pipe and chamber systems. These systems can reduce pollutants by settling out or filtering materials and any pollutants that may be bound to those materials. They are also effective at reducing nutrients, metals and other pollutants.

Basins with no outlet or highly restricted outlets can be effective at eliminating pollutants, but there is some risk of concentrating pollutants or introduction of pollutants to groundwater that must be considered. One way to address this is by the utilization of a biofilter, hydrodynamic separator (HDS), or other pollutant removal measures within or upstream of a basin that is sized to handle the water quality design storm. All infiltration basins shall be preceded by a pre-treatment or treatment system to capture and remove pollutants and coarse sediment particles, see requirements in the Water Quality section below.

Basins and galleries must be sized to drain within 48 hours after the end of the design storm and to not overtop in the 72-hour storm.

Underground injection wells are included in this category, but water quality and applicable regulations must be considered and utilized.

Rain Gardens

A rain garden is a planted depression or similar feature that allows storm runoff from impervious urban areas like roofs, driveways, walkways, parking lots, and compacted lawn areas the opportunity to infiltrate into the soil.

Rain gardens are an LID tool that can be used in new or established developments. Rain gardens can be constructed in commercial and residential sites. The garden may be located near a street or parking lot in a shallow depression where runoff can be diverted into it. Native perennial plants are recommended in rain gardens with a barrier to reduce weeds. Nutrients in the storm runoff are reduced as plants or other growing media make use of them to grow.

Rain gardens can be constructed to allow infiltration. Where complete infiltration is not desired or is not feasible due to existing soil conditions, an underdrain may be installed to convey excess water to a storm drain retention system.

Studies underway at Utah State University have identified common reed and sedges are the optimal plant for use in northern Utah to remove nutrients, metals, and other pollutants (Dupont and McLean), but it must be harvested and disposed of elsewhere at regular intervals to prevent concentration of pollutants in the soil or in the biofilters. Mulching and leaving in place does not address this. Whether such concentrations are critical depends on the contact with groundwater, and is still under study.

Root zone soil media must be shallow and water must pool or move slowly through the system or the pollutant removal is ineffective.

Rain garden filtration media shall meet the specification for biofilters (see Water Quality section below), are only allowed in private areas, and shall be maintained by the property owner.

Water Quality

Water quality is of utmost importance to Heber City. There are a variety of mechanisms to protect water quality from storm drain discharge systems. All storm water must pass through a pre-treatment or treatment system prior to discharging to a storage facility (above or below ground) that captures the 25-year to 100-year storm events. LID measures are intended to reduce storm runoff and to improve overall water quality. However, as most LID measures rely on infiltration, water quality must also be considered during design and implementation. Unless the native soil infiltration rate is less than 6.0 in/hr and/or the LID facility is designed and determined to treat the storm water (biofilter treatment), an approved hydrodynamic separator (HDS) pre-treatment device shall be used prior discharging to LID systems. All storm water that flows over an impervious surface must be treated.

Pre-treatment and Treatment Systems

Pre-treatment and treatment systems shall be sized, at a minimum, to treat the 2-year storm event at the duration that produces the highest flow rate while also being able to by-pass the peak conveyance storm at the time of concentration (T_c) without disrupting the treatment system. The peak conveyance storm represents the actual capacity of the initial conveyance system and may be larger than the 10-year event. Note, treatment systems that also serve as LID retention areas may be sized for the 80th percentile storm event but shall adhere to the by-pass requirements stated above. Requirements for pre-treatment and treatment are listed below.

Oil-Water and Hydrodynamic Separators (HDS) Pre-Treatment Devices:

All developments are required to install an appropriately sized hydrodynamic separator (HDS) prior to discharging to the retention/detention storage facility that captures the 25-year to 100-year storm events unless the LID methods utilized in the development incorporate a sized biofilter per the specification listed below and the storm water is not re-introduced to a source of pollution after it flows through the localized LID methods. Pre-treatment devices shall be maintained at least twice per year and per the guidelines provided by the manufacturer. All HDS devices must achieve, at a minimum, the following treatment levels:

- The HDS system shall be required to have a General Use Level Designation (GULD) performance verification through the TAPE program (Emerging stormwater treatment technologies (TAPE) - Washington State Department of Ecology). The device shall be sized to treat the peak runoff flow rate generated by the 2-year storm event at the Tc, when using Rational Method. Use the storm duration and distribution that creates the highest flow rate during a 2-year storm event when using other run-off computation methods.The proposed hydraulic loading rate (HLR) must not exceed the design HLR of the proposed device to be used. TAPE approval letters can be found on the website and provide the design HLR and/or the maximum treatment flow rate for each model.
- The HDS system shall be concrete unless otherwise approved by the City Engineer
- The HDS system shall provide 90% removal of trash and neutrally buoyant material larger than 5mm at the design treatment flow rate. Adding a screen to the tested system is not allowed to meet this spec, as modifying a TAPE verified system with a screen can significantly affect hydraulics, and thus water quality performance.

- The HDS system shall be designed to by-pass the peak conveyance storm event and prevent these larger storm events from washing out the oil, debris, and sediment that has been previously captured (off-line storage).
- The HDS system shall provide a minimum sump and oil storage capacity as follows:

Treatment Capacity Range (cfs)	Minimum Sump Storage Capacity (yd^3)	Minimum Oil Capacity (gal)
0-4	> 0.4	> 60
4-9	> 2	> 200
9-20	> 4	> 500
> 20	> 8	> 1000

Biofilter Treatment Systems: Biofilter is a generic description for bioswales, vegetated filter strips, rain gardens, or other structures that use a filtration media to capture storm water pollutants. The pollutants are decomposed by a biomass such as plants, a tree, or a specially designed biofilter media. These systems are typically connected to a storm drain system and if used shall be combined with detention/retention facilities.

All biofilters shall be sized to treat the 2-year T_c storm event flow rate while also be sized to by-pass larger flows without disrupting the treatment system. Biofilters shall treat the storm water prior to infiltrating into the native soils with infiltration rates greater than 6.0 in/hr and/or prior to discharging to a detention/retention facility unless a sized HDS system is properly incorporated as pre-treatment.

The growing media of the biofilter and shall be designed and certified to meet the following specifications.

RAIN GARDEN GROWING MEDIA (Soil + Organics)

Assume a saturated hydraulic conductivity rate of 2.0 in/hr. Then, divide it by a safety factor of 2.0. So, the net rate is 1.0 in/hr.

RAIN GARDEN SOIL

Particle Size Distribution

sand: 70-80%

silt: 0-30%

clay: 0-15%

Chemical Attribute and Nutrient Analysis

pH: 6.8-7.5

organic matter: < 1.5%

nitrogen: < 15 ppm

phosphorous: < 15 ppm

salinity: < 6 mmhos/cm

RAIN GARDEN ORGANICS

shredded mulch: 3-5% (by weight of growing media)

VEGETATION

The filter area shall be vegetated with drought tolerant species that thrive in sandy soils. Table 3 provides a suggested seed mix for sites that will not need to be irrigated after the grass has been established.

Table 3. Suggested Seed Mix

Common Name	Scientific Name	Variety	PLS[2] lbs per Acre	Ounces per Acre
Sand bluestem	Andropogon hallii	Garden	3.5	
Sideoats grama	Bouteloua curtipendula	Butte	3	
Prairie sandreed	Calamovilfa longifolia	Goshen	3	
Indian ricegrass	Oryzopsis hymenoides	Paloma	3	
Switchgrass	Panicum virgatum	Blackwell	4	
Western wheatgrass	Pascopyrum smithii	Ariba	3	
Little bluestem	Schizachyrium scoparium	Patura	3	
Alkali sacaton	Sporobolus airoides		3	
Sand dropseed	Sporobolus cryptandrus		3	
Pasture sage[1]	Artemisia frigida			2
Blue aster[1]	Aster laevis			4
Blanket flower[1]	Gaillardia aristata			8
Prairie coneflower[1]	Ratibida columnifera			4
Purple prairieclover[1]	Dalea (Petalostemum) purpurea			4
Sub-Totals:			27.5	22
Total lbs per acre:			**28.9**	

[1] Wildflower seed (optional) for a more diverse and natural look.
[2] PLS = Pure Live Seed.

EXECUTION

thickness: >/= 18 inches

compaction: 80-85% of maximum dry density as measured by AASHTO T-99 (ASTM D698)

vegetation: Mix seed well and broadcast, followed by hand raking to cover seed and then mulched. Hydromulching can be effective for large areas. Do not place seed when standing water or snow is present or if the ground is frozen. Weed control is critical in the first two to three years, especially when starting with seed. When using sod, specify sand–grown sod. Do

not use conventional sod. Conventional sod is grown in clay soil that will seal the filter area, greatly reducing overall function of the BMP.

Irrigation: Provide spray irrigation at or above the WQCV elevation or place temporary irrigation on top of the rain garden surface. Do not place sprinkler heads on the flat surface. Remove temporary irrigation when vegetation is established. If left in place this will become buried over time and will be damaged during maintenance operations. Adjust irrigation schedules during the growing season to provide the minimum water necessary to maintain plant health and to maintain the available pore space for infiltration.

Water Quality Control Measures

Other water quality control requirements are listed below.

Detention/Retention Facilities (Pollutant Control, LID): Detention basins are used to attenuate peak flow rates of a runoff hydrograph. They also can be designed to allow sediment, debris, and other contaminants to settle out by reducing water velocity or holding the water until it infiltrates or evaporates.

Retention facilities have no outlet and water is removed by infiltration or evaporation. Retention basins still function as a BMP the same way a detention basin does. Detention and retention facilities shall be used in combination with hydrodynamic separators or biofiltration systems.

These facilities require regular maintenance to remove debris, contaminants, and sediment build-up.

Outlet Protection/Energy Dissipation Devices: Outlet protection reduces or eliminates soil erosion thereby preventing the migration of soil to downstream channels. Outlet protection, pursuant to HEC 14, is required at all open discharge points.

Slope Protection: Slope protection ensures slopes will be stable during and after construction. The primary means of stabilization of a slope is establishing permanent vegetation, but may also consist of temporary or permanent rock, mulch, erosion control blankets, check dams, diversion dikes, or other means of protection. All slopes shall be stabilized after disturbance. Slopes of 3H:1V and steeper require permanent slope stabilization.

Source Protection

The Utah Division of Drinking Water requires that each well and spring serving a public drinking water system must have a source protection plan. Part of that plan includes the protection of groundwater from point and non-point sources. Developers within Heber must certify that all private and public source protection zones are protected from storm water pollutants. Source protection zones for Heber City culinary water sources are shown on the source protection maps in Appendix H.

Storm water infiltration, drainage wells, or storm water injection wells are prohibited within 100 feet of Zone 1 of any source protection area. All storm drain storage facilities within 100 feet of a Zone 1 area shall be lined with an approved waterproof liner to prevent all storm water infiltration.

Natural Channels

Natural or manmade drainage channels shall remain undeveloped with a total width minimum 100-feet undeveloped buffer split between both sides of the channel. The entire drainage channel shall be protected and remain undisturbed with the exception of road or other crossings. Road crossings of the natural channels shall be minimized with a minimum distance, measured along the channel, between crossings of 250-feet. Relocation of drainage channels shall be approved by governing entities and Heber City.

Flood and Debris Flow Hazards

FEMA Flood Analysis

Ensure all pertinent FEMA flood mapping data is incorporated into plans and plats maps. Ensure all FEMA guidelines from https://www.fema.gov are followed including the sections on Floods & Maps, Floodplain Management, and Flood Insurance. FEMA uses the most accurate flood hazard information available and applies rigorous standards in developing Flood Insurance Rate Maps (FIRMs). All areas within Flood Hazard Areas shall be shown on plans and plats, and all Base Flood Elevation (BFE) data pertinent to the development must be provided.

To change the FIRM designation of a property, a Letter of Map Amendment (LOMA) and/or the Letter of Map Revision-Based on Fill (LOMR-F) processes must be strictly followed.

Debris-Flow Flood Hazard Analysis

The Western Unities states is beginning to see increased precipitation intensity and increasing fire size and frequency (Kean and Staley et al, 2021). Generally, there is not adequate time to prevent or mitigate a debris flow hazard *after* a wildfire has taken place. The USGS has found that 1-year storm events will typically trigger a post-wildfire debris flow event. Therefore, if a wildfire takes place, some type of debris flow is likely to happen within 1-year of the fire. These types of hazards should be prevented or controlled as deemed feasible. New development with undeveloped land upstream or downstream of the property containing natural slopes 30% and greater and/or where the City Engineer determines there could be a potential debris-flow risk, requires a specialized post wild-fire debris-flow analysis of the site including an estimated post-fire hazard assessment with mitigation measures.

Flood and Debris-flow hazard analysis reports shall include but shall not be limited to the following information for the areas to be developed:

- FEMA Flood Mapping Data including 100-year flood hazard zones
- Include and label the drainageways susceptible to periodic flooding associated with storm events or rapid snowmelt that are outside the FEMA designated flood zones
- U.S. Geological Survey Map
- Aerial Map
- Contour map with slopes labeled
- Geotechnical Test pit data
- Geologic Mapping Data to include historic upstream and downstream alluvial fan deposits and historic upstream or pass-through debris/mud flows as data is available.
- Vegetative cover type and percentage analysis

- Utah Division of Water Rights – Dam Safety requirements
- Post-fire debris-flow volume calculations with flood and post-fire debris-flow hazard assessment and mitigation

Flood and post-fire debris-flow hazard assessment and mitigation recommendations shall adhere to the following guidelines:

At a minimum, the volume of debris sediment shall be calculated using the model equation (2) from the 2010 Cannon study (Cannon et al,, 2010). The entire drainage basin shall be modeled. Methods from the Gartner 2014 study and equation (3) may also be used until another model paper is published and adopted by USGS. (Gartner et al., 2014).

The minimum storm event interval shall be a 10-year occurrence with a T_c peak rainfall depth, unless otherwise approved by the City Engineer. Intensity is used for the Gartner method.

When the Gartner method is used, the watershed area burned at moderate to high severity shall be calculated based on a vegetation type assessment of the entire drainage basin. Vegetation type and coverage area data shall be obtained and summarized under the direction of a licensed Professional Engineer or other approved licensed professional. Forested areas and other areas with small or large tree species (deciduous or evergreen) and/or thick brush, such as Gambel Oak shall be assumed to burn at moderate to high severity. Staley et al. (2018) spells out further guidance on vegetation types and burn severity per vegetation type.

Debris flow is difficult to accurately model due to the nature of the material being carried by the storm water, especially if the natural channel that the debris flow will enter and travel through is altered by road crossings, culverts, or other diversions/obstructions over and through the natural channel. Unless the natural channel is undisturbed and can be accurately modeled to safely convey the debris flow without having to travel through any obstructions, culverts, roads, etc. that would otherwise plug or divert the flow off-course, the estimated debris volume needs to be contained in a debris-basin upstream from development. Road or other crossings shall be designed to allow and divert debris flow and/or flood water over the crossing using depression or other mechanism to allow the flow to pass the crossing continue down the natural channel. Other measures to contain and/or divert the debris volume may be considered, as approved by the City Engineer.

References

Cannon, S.H., Gartner, J.E., Rupert, M.G., Michael, J.A., Rea, A.H., & Parrett, C. (2010). Predicting the probability and volume of postwildfire debris flows in the intermountain western United States. *GSA Bulletin*, *v. 122*(1-2), 127-144. https://doi.org/10.1130/B26459.1

Gartner, J.E., Cannon, S.H., & Santi, P.M. (2014). Empirical models for predicting volumes of sediment deposited by debris flows and sediment-laden floods in the transverse ranges of southern California. *Engineering Geology*, *176*, 45-56. https://doi.org/10.1016/j.enggeo.2014.04.008

Kean, J.W., & Staley, D.M. (2021). Forecasting the frequency and magnitude of postfire debris flows across southern California. *Earth's Future*, *9*(3), e2020EF001735. https://doi.org/10.1029/2020EF001735

Staley, D.M., Tillery, A.C., Kean, J.W., McGuire, L.A., Pauling, H.E., Rengers, F.K., & Smith, J.B. (2018). Estimating post-fire debris-flow hazards prior to wildfire using a statistical analysis of historical distributions of fire severity from remote sensing data. *International Journal of Wildland Fire*, *27*(9), 595-608. https://doi.org/10.1071/WF17122

Appendices

Appendix A

Drainage Design Resources

Standard Drawings | Heber City, UT (heberut.gov)

Standard Specifications | Heber City, UT (heberut.gov)

Storm-Intensity-Curves-PDF (heberut.gov)

Low Impact Development - Utah Department of Environmental Quality

DWQ-2019-000161.pdf (utah.gov)

Microsoft PowerPoint - A Guide to Low Impact Development within Utah (Training)

Emerging stormwater treatment technologies (TAPE) - Washington State Department of Ecology

Nonpoint Source: Urban Areas | US EPA

DRAFT

Appendix B

(IDF Data)

Precipitation Frequency Estimates (in/hr)										
Average recurrence interval (years)	5-min	10-min	15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
1	1.54	1.16	0.96	0.646	0.4	0.251	0.191	0.126	0.079	0.047
2	1.94	1.48	1.22	0.824	0.51	0.314	0.237	0.155	0.097	0.058
5	2.68	2.03	1.68	1.13	0.699	0.413	0.302	0.191	0.118	0.072
10	3.34	2.54	2.1	1.41	0.873	0.505	0.364	0.223	0.137	0.083
25	4.38	3.34	2.76	1.86	1.15	0.656	0.46	0.27	0.163	0.099
50	5.38	4.09	3.38	2.27	1.41	0.794	0.545	0.31	0.185	0.112
100	6.52	4.96	4.1	2.76	1.71	0.958	0.647	0.355	0.209	0.125
200	7.86	5.98	4.94	3.33	2.06	1.15	0.772	0.405	0.234	0.14
500	10	7.63	6.31	4.25	2.63	1.46	0.985	0.499	0.273	0.159
1000	12	9.13	7.55	5.08	3.14	1.75	1.18	0.597	0.307	0.175

Precipitation Frequency Estimates (inches)										
Average recurrence interval (years)	5-min	10-min	15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
1	0.13	0.19	0.24	0.32	0.40	0.50	0.57	0.75	0.95	1.13
2	0.16	0.25	0.31	0.41	0.51	0.63	0.71	0.93	1.17	1.40
5	0.22	0.34	0.42	0.57	0.70	0.83	0.91	1.14	1.43	1.72
10	0.28	0.42	0.52	0.71	0.87	1.01	1.09	1.34	1.65	2.00
25	0.37	0.56	0.69	0.93	1.15	1.31	1.38	1.62	1.97	2.38
50	0.45	0.68	0.84	1.14	1.41	1.59	1.64	1.86	2.23	2.69
100	0.54	0.83	1.03	1.38	1.71	1.92	1.94	2.12	2.51	3.01
200	0.66	1.00	1.24	1.66	2.06	2.30	2.32	2.43	2.82	3.35
500	0.84	1.27	1.58	2.12	2.63	2.93	2.96	2.99	3.29	3.82
1000	1.00	1.52	1.89	2.54	3.14	3.50	3.54	3.57	3.70	4.20

NOAA Atlas 14, Volume 1, Version 5 (Feb 2022)
Location name: Heber City, Utah, USA
Latitude: 40.4924°, Longitude: -111.4129°
Elevation: 5642.1 ft
Refer to NOAA Atlas 14 document for more information

NOAA Atlas 14, Volume 1, Version 5
Location name: Heber City, Utah, USA*
Latitude: 40.4924°, Longitude: -111.4129°
Elevation: 5642.1 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.128** (0.111-0.149)	**0.162** (0.142-0.190)	**0.223** (0.194-0.261)	**0.278** (0.239-0.326)	**0.365** (0.306-0.433)	**0.448** (0.364-0.533)	**0.543** (0.428-0.653)	**0.655** (0.496-0.799)	**0.836** (0.601-1.04)	**1.00** (0.689-1.27)
10-min	**0.194** (0.169-0.227)	**0.247** (0.215-0.289)	**0.338** (0.294-0.397)	**0.423** (0.363-0.497)	**0.556** (0.465-0.659)	**0.681** (0.553-0.811)	**0.827** (0.651-0.994)	**0.997** (0.755-1.22)	**1.27** (0.914-1.59)	**1.52** (1.05-1.94)
15-min	**0.240** (0.210-0.282)	**0.306** (0.267-0.359)	**0.420** (0.365-0.493)	**0.524** (0.450-0.615)	**0.690** (0.576-0.816)	**0.844** (0.686-1.00)	**1.02** (0.807-1.23)	**1.24** (0.936-1.51)	**1.58** (1.13-1.97)	**1.89** (1.30-2.40)
30-min	**0.323** (0.282-0.380)	**0.412** (0.359-0.483)	**0.565** (0.491-0.663)	**0.706** (0.606-0.829)	**0.929** (0.776-1.10)	**1.14** (0.924-1.35)	**1.38** (1.09-1.66)	**1.66** (1.26-2.03)	**2.12** (1.53-2.65)	**2.54** (1.75-3.24)
60-min	**0.400** (0.349-0.470)	**0.510** (0.445-0.598)	**0.699** (0.608-0.821)	**0.873** (0.750-1.03)	**1.15** (0.960-1.36)	**1.41** (1.14-1.68)	**1.71** (1.34-2.05)	**2.06** (1.56-2.51)	**2.63** (1.89-3.28)	**3.14** (2.16-4.01)
2-hr	**0.502** (0.447-0.578)	**0.627** (0.559-0.719)	**0.826** (0.732-0.950)	**1.01** (0.885-1.16)	**1.31** (1.12-1.52)	**1.59** (1.32-1.85)	**1.92** (1.54-2.27)	**2.30** (1.78-2.77)	**2.93** (2.15-3.62)	**3.50** (2.46-4.43)
3-hr	**0.573** (0.515-0.649)	**0.712** (0.640-0.804)	**0.908** (0.810-1.03)	**1.09** (0.967-1.24)	**1.38** (1.20-1.57)	**1.64** (1.39-1.88)	**1.94** (1.60-2.28)	**2.32** (1.84-2.80)	**2.96** (2.22-3.65)	**3.54** (2.54-4.47)
6-hr	**0.754** (0.690-0.838)	**0.929** (0.847-1.03)	**1.14** (1.04-1.28)	**1.34** (1.21-1.49)	**1.62** (1.44-1.81)	**1.86** (1.62-2.09)	**2.12** (1.82-2.42)	**2.43** (2.03-2.81)	**2.99** (2.42-3.69)	**3.57** (2.76-4.51)
12-hr	**0.954** (0.875-1.05)	**1.17** (1.07-1.30)	**1.43** (1.30-1.58)	**1.65** (1.50-1.82)	**1.97** (1.76-2.19)	**2.23** (1.97-2.50)	**2.51** (2.18-2.85)	**2.82** (2.40-3.24)	**3.29** (2.71-3.86)	**3.70** (2.98-4.56)
24-hr	**1.13** (1.06-1.21)	**1.40** (1.31-1.50)	**1.72** (1.62-1.85)	**2.00** (1.87-2.13)	**2.38** (2.21-2.54)	**2.69** (2.48-2.87)	**3.01** (2.77-3.21)	**3.35** (3.06-3.58)	**3.82** (3.45-4.10)	**4.20** (3.76-4.61)
2-day	**1.30** (1.22-1.40)	**1.62** (1.51-1.74)	**1.98** (1.85-2.12)	**2.28** (2.13-2.44)	**2.71** (2.52-2.90)	**3.04** (2.81-3.25)	**3.39** (3.11-3.62)	**3.75** (3.42-4.02)	**4.24** (3.83-4.56)	**4.63** (4.14-5.00)
3-day	**1.44** (1.35-1.54)	**1.78** (1.67-1.92)	**2.18** (2.05-2.34)	**2.52** (2.35-2.69)	**2.97** (2.77-3.18)	**3.34** (3.09-3.57)	**3.71** (3.42-3.97)	**4.09** (3.75-4.39)	**4.62** (4.19-4.97)	**5.03** (4.52-5.44)
4-day	**1.57** (1.48-1.69)	**1.95** (1.83-2.09)	**2.39** (2.24-2.56)	**2.75** (2.57-2.94)	**3.24** (3.03-3.47)	**3.63** (3.37-3.89)	**4.03** (3.73-4.32)	**4.44** (4.08-4.77)	**5.00** (4.55-5.39)	**5.44** (4.90-5.88)
7-day	**1.87** (1.74-2.02)	**2.30** (2.15-2.49)	**2.81** (2.62-3.04)	**3.23** (3.00-3.49)	**3.80** (3.53-4.11)	**4.25** (3.92-4.59)	**4.71** (4.33-5.10)	**5.18** (4.73-5.61)	**5.82** (5.26-6.34)	**6.31** (5.67-6.90)
10-day	**2.14** (1.98-2.31)	**2.64** (2.46-2.85)	**3.21** (2.99-3.47)	**3.67** (3.40-3.96)	**4.29** (3.97-4.63)	**4.75** (4.39-5.14)	**5.23** (4.80-5.65)	**5.70** (5.22-6.18)	**6.34** (5.75-6.88)	**6.81** (6.14-7.44)
20-day	**2.81** (2.63-3.02)	**3.47** (3.25-3.74)	**4.20** (3.93-4.51)	**4.76** (4.45-5.11)	**5.50** (5.13-5.91)	**6.05** (5.63-6.50)	**6.60** (6.11-7.10)	**7.13** (6.58-7.69)	**7.81** (7.16-8.44)	**8.31** (7.60-9.02)
30-day	**3.40** (3.19-3.62)	**4.20** (3.95-4.47)	**5.03** (4.73-5.35)	**5.66** (5.32-6.02)	**6.49** (6.09-6.89)	**7.08** (6.64-7.54)	**7.67** (7.17-8.18)	**8.23** (7.68-8.78)	**8.94** (8.28-9.56)	**9.45** (8.72-10.1)
45-day	**4.28** (4.02-4.57)	**5.28** (4.96-5.64)	**6.31** (5.93-6.72)	**7.09** (6.65-7.55)	**8.08** (7.56-8.60)	**8.79** (8.20-9.35)	**9.47** (8.81-10.1)	**10.1** (9.38-10.8)	**10.9** (10.1-11.6)	**11.4** (10.5-12.3)
60-day	**5.09** (4.79-5.42)	**6.28** (5.91-6.70)	**7.45** (7.02-7.93)	**8.32** (7.83-8.84)	**9.39** (8.82-9.97)	**10.1** (9.50-10.8)	**10.8** (10.2-11.5)	**11.5** (10.7-12.2)	**12.3** (11.4-13.1)	**12.8** (11.9-13.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

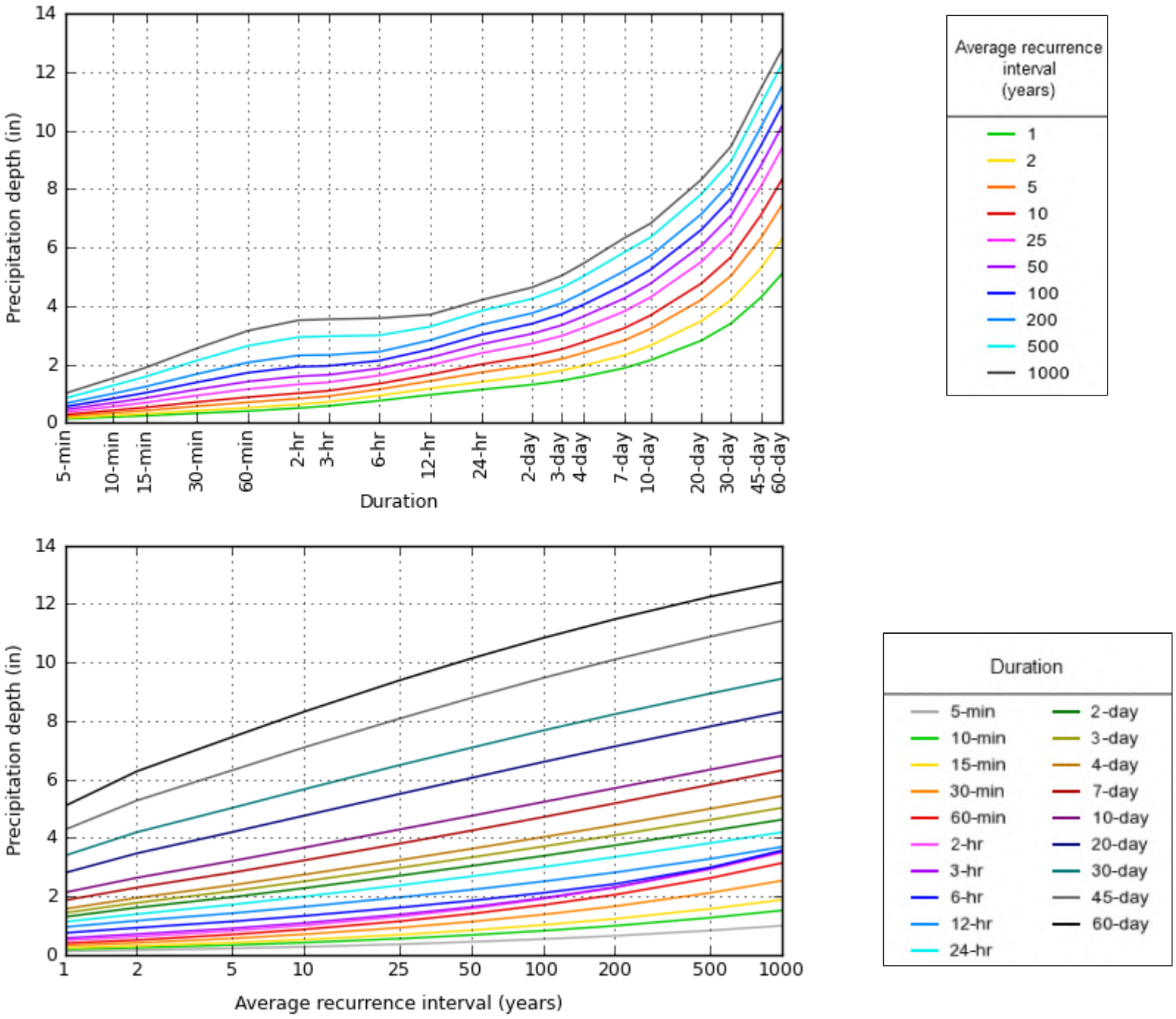
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.4924°, Longitude: -111.4129°

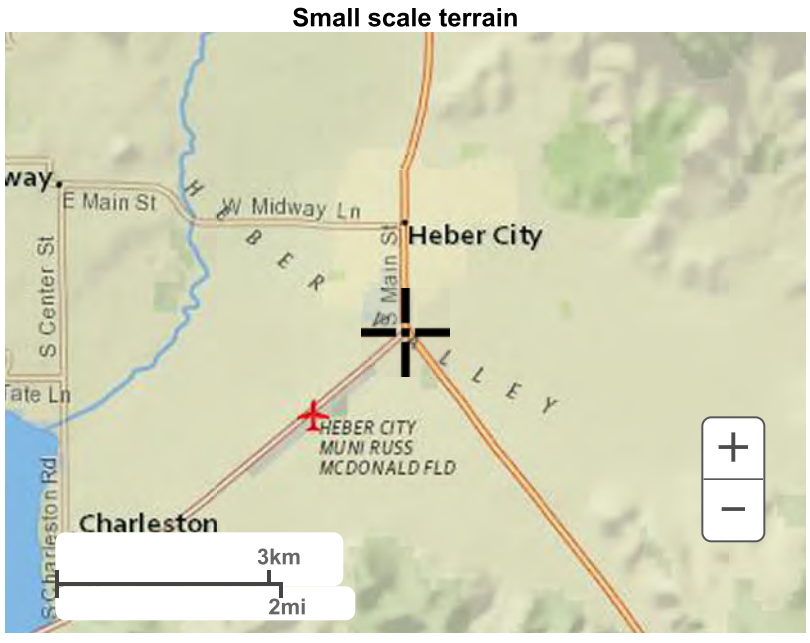


NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Thu Feb 10 17:47:32 2022

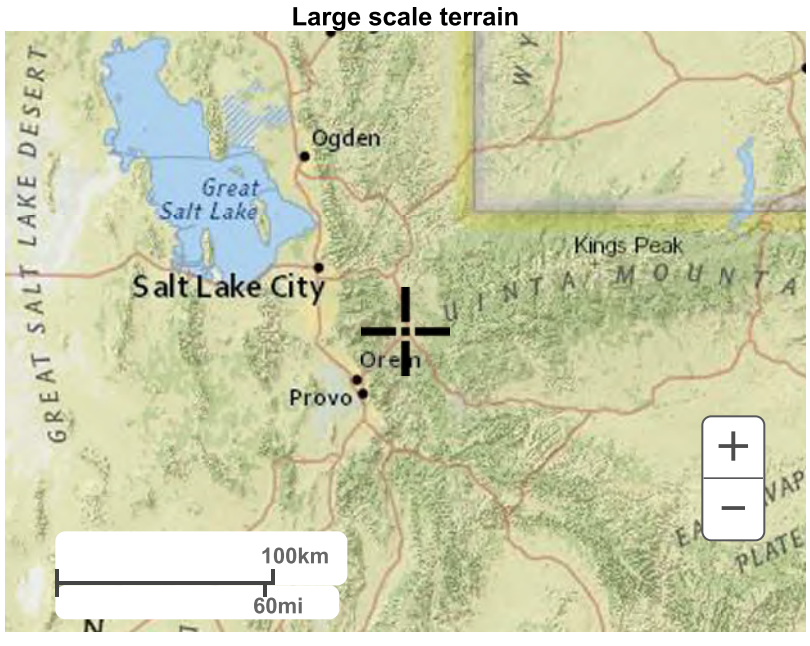
Back to Top

Maps & aerials

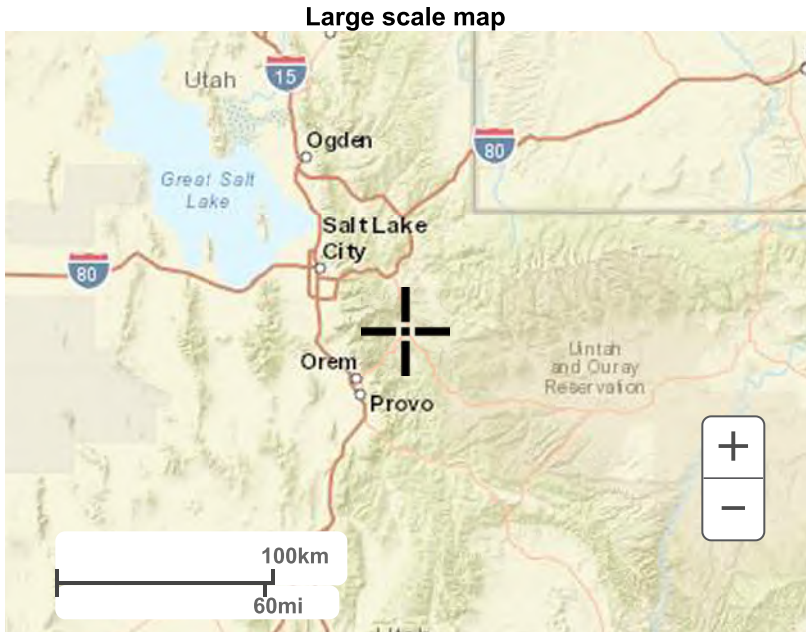
Small scale terrain



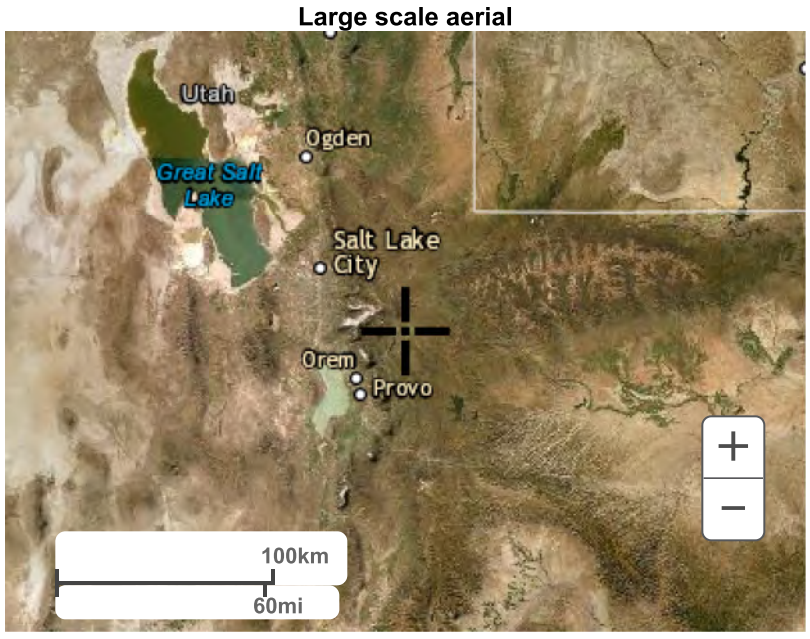
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix C

(CN Tables)

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

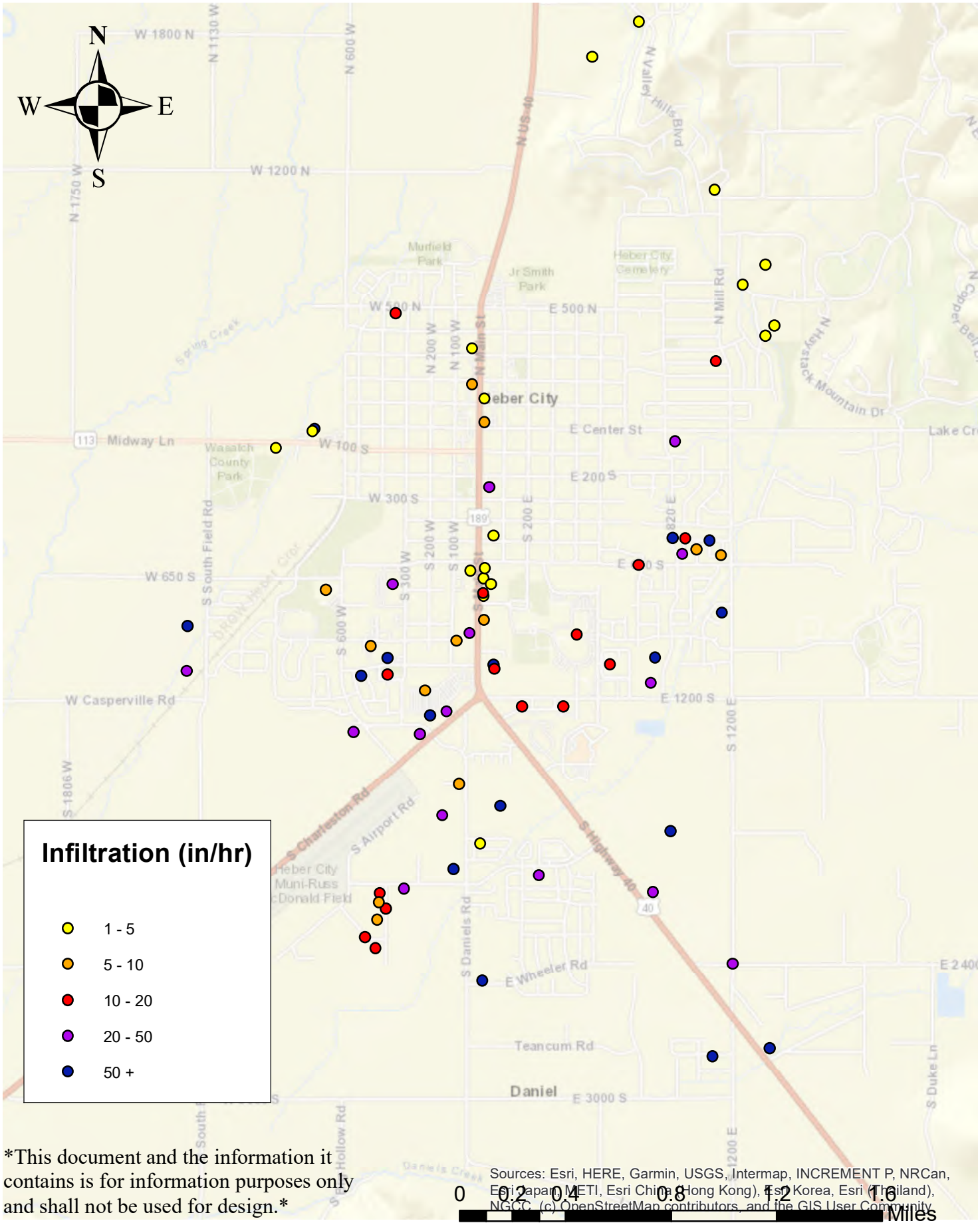
Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Appendix D

(Infiltration & Groundwater Maps)



This document and the information it contains is for information purposes only and shall not be used for design.

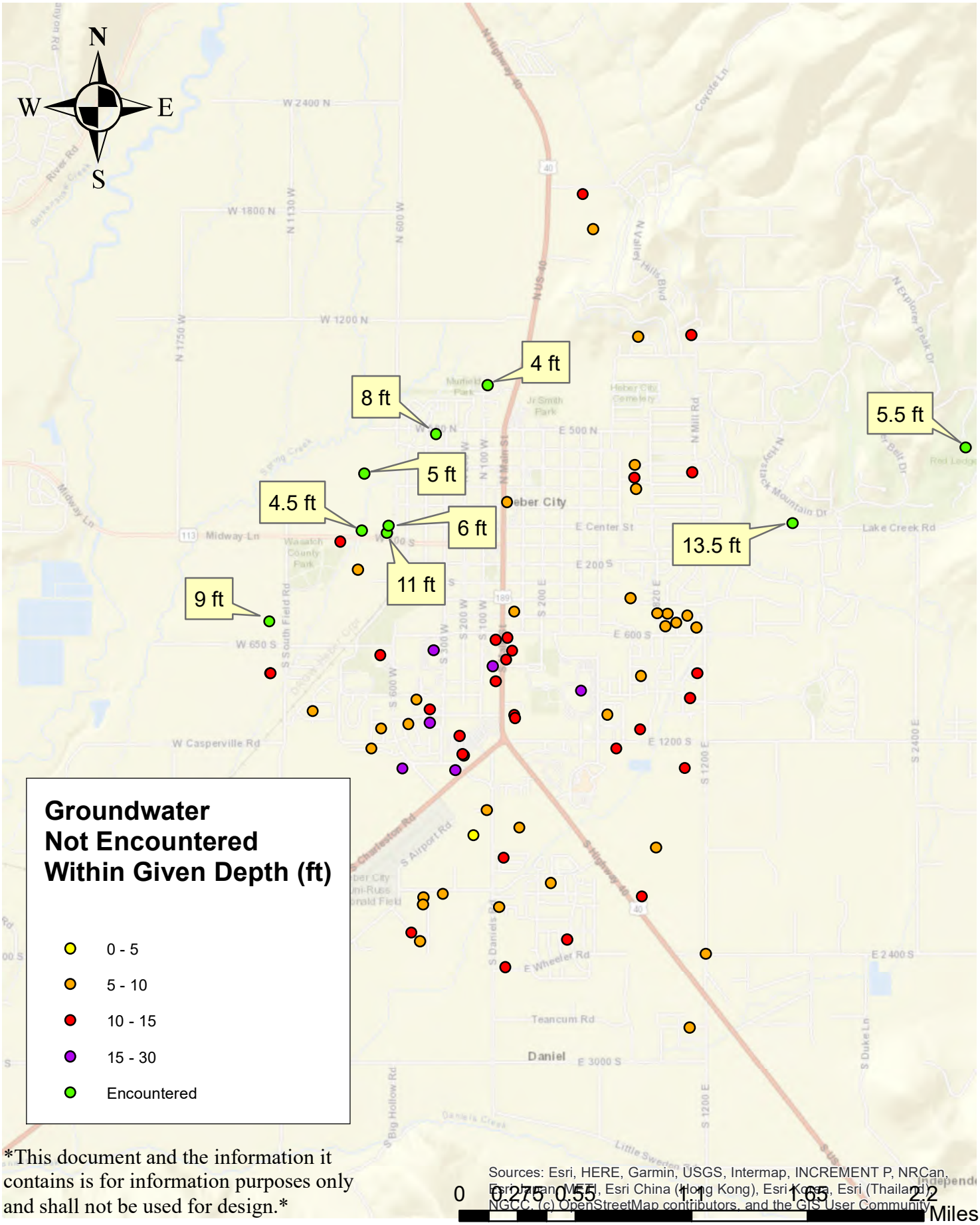
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

C:\Users\alecvandegraaff\Desktop\Heber Master Plan\Infiltration_BACKUP.mxd, 6/9/2022 10:23:31 AM, alecvandegraaff

HORROCKS ENGINEERS
728 West 100 South
Heber, UT 84032
(435) 654-2226

Infiltration Rate

DATE 6/9/2022
DRAWN



This document and the information it contains is for information purposes only and shall not be used for design.

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

C:\Users\alecvandegraaff\Desktop\Heber Master Plan\groundwater_BACKUP.mxd 6/9/2022 11:27:35 AM alecvandegraaff

HORROCKS ENGINEERS

728 West 100 South
Heber, UT 84032
(435) 654-2226

Groundwater Depth

DATE 6/9/2022

DRAWN

Appendix E

(80th Percentile Calculations)

HEBER CITY NOAA RAINFALL DATA

PDS-based precipitation frequency estimates with 90% confidence intervals 1
Duration Average recurrence interval
https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut

	100	50	20	10	4	2	1	0.5	0.2	0.1
	1	2	5	10	25	50	100	200	500	1000
5-min	0.127	0.161	0.221	0.275	0.363	0.445	0.541	0.653	0.836	1
10-min	0.193	0.245	0.336	0.419	0.552	0.678	0.823	0.995	1.27	1.53
15-min	0.239	0.304	0.416	0.52	0.685	0.84	1.02	1.23	1.58	1.89
30-min	0.322	0.409	0.561	0.7	0.922	1.13	1.37	1.66	2.12	2.55
60-min	0.398	0.506	0.694	0.866	1.14	1.4	1.7	2.06	2.63	3.15
2-hr	0.504	0.628	0.825	1.01	1.31	1.59	1.91	2.3	2.94	3.52
3-hr	0.579	0.719	0.915	1.1	1.39	1.65	1.95	2.32	2.96	3.55
6-hr	0.764	0.941	1.16	1.35	1.63	1.87	2.14	2.44	3.01	3.59
12-hr	0.972	1.19	1.45	1.67	2	2.26	2.55	2.87	3.34	3.75
24-hr	1.18	1.46	1.77	2.03	2.4	2.69	2.99	3.3	3.73	4.06
2-day	1.37	1.69	2.05	2.34	2.75	3.06	3.38	3.71	4.16	4.5
3-day	1.53	1.88	2.27	2.6	3.04	3.39	3.75	4.11	4.6	4.98
4-day	1.68	2.07	2.5	2.85	3.34	3.72	4.11	4.51	5.04	5.45
7-day	2.01	2.47	2.98	3.4	3.96	4.39	4.84	5.29	5.88	6.33
10-day	2.29	2.82	3.39	3.84	4.44	4.89	5.34	5.78	6.35	6.77
20-day	3.02	3.72	4.45	5.01	5.73	6.26	6.78	7.27	7.89	8.32
30-day	3.67	4.5	5.34	5.99	6.81	7.4	7.97	8.51	9.18	9.65
45-day	4.6	5.65	6.68	7.47	8.46	9.16	9.83	10.4	11.2	11.7
60-day	5.47	6.71	7.91	8.8	9.91	10.7	11.4	12.1	12.8	13.3

PARK CITY NOAA RAINFALL DATA

PDS-based precipitation frequency estimates with 90% confidence intervals 1
Duration Average recurrence interval

	100	50	20	10	4	2	1	0.5	0.2	0.1
	1	2	5	10	25	50	100	200	500	1000
5-min	0.128	0.162	0.222	0.277	0.367	0.451	0.549	0.665	0.854	1.03
10-min	0.195	0.247	0.338	0.422	0.558	0.687	0.836	1.01	1.3	1.56
15-min	0.241	0.306	0.419	0.524	0.692	0.851	1.04	1.25	1.61	1.94
30-min	0.325	0.412	0.565	0.705	0.932	1.15	1.4	1.69	2.17	2.61
60-min	0.402	0.51	0.699	0.873	1.15	1.42	1.73	2.09	2.69	3.23
2-hr	0.515	0.641	0.839	1.02	1.33	1.61	1.95	2.34	2.99	3.59
3-hr	0.595	0.737	0.933	1.12	1.41	1.67	1.99	2.36	3.02	3.62
6-hr	0.793	0.975	1.19	1.39	1.68	1.92	2.19	2.51	3.09	3.65
12-hr	1.01	1.24	1.5	1.73	2.07	2.35	2.65	2.98	3.47	3.89
24-hr	1.31	1.6	1.92	2.18	2.55	2.84	3.13	3.44	3.84	4.16
2-day	1.56	1.92	2.3	2.62	3.05	3.38	3.73	4.08	4.55	4.91
3-day	1.74	2.14	2.57	2.93	3.43	3.81	4.21	4.62	5.16	5.59
4-day	1.92	2.36	2.84	3.25	3.8	4.24	4.69	5.15	5.78	6.27
7-day	2.32	2.86	3.43	3.91	4.57	5.08	5.6	6.13	6.84	7.39
10-day	2.65	3.26	3.9	4.41	5.09	5.6	6.11	6.61	7.27	7.76
20-day	3.47	4.27	5.06	5.67	6.46	7.03	7.59	8.13	8.79	9.27
30-day	4.2	5.15	6.08	6.8	7.72	8.39	9.04	9.66	10.4	11
45-day	5.16	6.32	7.44	8.31	9.43	10.2	11	11.8	12.7	13.3
60-day	6.13	7.52	8.83	9.84	11.1	12	12.9	13.7	14.7	15.4

DIFFERENCE

AVERAGE(0.5 X HEBER CITY / PARK CITY) = 0.47

0.496	0.497	0.498	0.496	0.495	0.493	0.493	0.491	0.489	0.485
0.495	0.496	0.497	0.496	0.495	0.493	0.492	0.493	0.488	0.490
0.496	0.497	0.496	0.496	0.495	0.494	0.490	0.492	0.491	0.487
0.495	0.496	0.496	0.496	0.495	0.491	0.489	0.491	0.488	0.489
0.495	0.496	0.496	0.496	0.496	0.493	0.491	0.493	0.489	0.488
0.489	0.490	0.492	0.495	0.492	0.494	0.490	0.491	0.492	0.490
0.487	0.488	0.490	0.491	0.493	0.494	0.490	0.492	0.490	0.490
0.482	0.483	0.487	0.486	0.485	0.487	0.489	0.486	0.487	0.492
0.481	0.480	0.483	0.483	0.483	0.481	0.481	0.482	0.481	0.482
0.450	0.456	0.461	0.466	0.471	0.474	0.478	0.480	0.486	0.488
0.439	0.440	0.446	0.447	0.451	0.453	0.453	0.455	0.457	0.458
0.440	0.439	0.442	0.444	0.443	0.445	0.445	0.445	0.446	0.445
0.438	0.439	0.440	0.438	0.439	0.439	0.438	0.438	0.436	0.435
0.433	0.432	0.434	0.435	0.433	0.432	0.432	0.431	0.430	0.428
0.432	0.433	0.435	0.435	0.436	0.437	0.437	0.437	0.437	0.436
0.435	0.436	0.440	0.442	0.443	0.445	0.447	0.447	0.449	0.449
0.437	0.437	0.439	0.440	0.441	0.441	0.441	0.440	0.441	0.439
0.446	0.447	0.449	0.449	0.449	0.449	0.447	0.441	0.441	0.440
0.446	0.446	0.448	0.447	0.446	0.446	0.442	0.442	0.435	0.432

The 80th Percentile Volume

LID Impact on Hydrology

Storm water programs have focused on the goal of mimicking predevelopment hydrologic conditions over the last several decades as municipal and department of transportation (DOT) storm water programs have increased their efforts to comply with the Federal Clean Water Act of 1972 and their associated MS4 permits. LID BMPs, green infrastructure practices, and retention of the 80th percentile volume or of the predevelopment hydrologic condition are tools and requirements that are used to accomplish this goal.

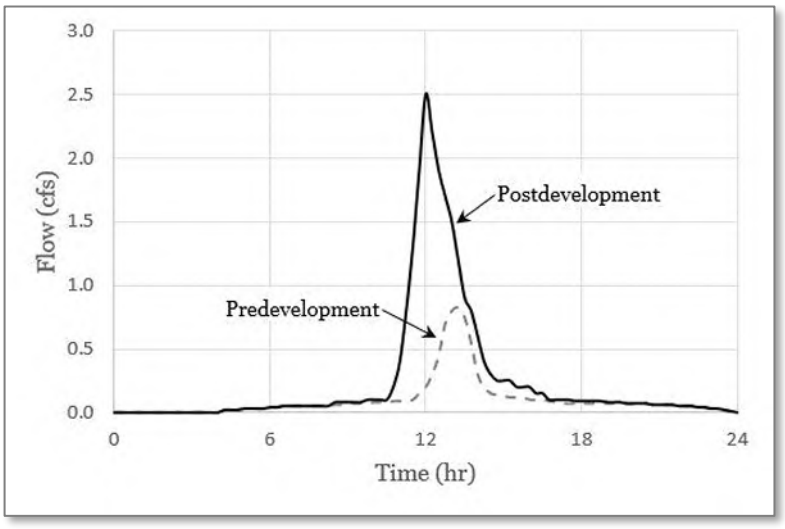


Figure 9: Typical hydrologic impact of development on-site hydrology.

More frequent peak flows, higher peak flows, and higher runoff volumes are well-documented hydrologic impacts of urbanization and development due to an increase in impervious surfaces (D.B. Booth, 1997; Konrad & Booth, 2002) (*Figure 9*).

Traditional approaches to storm water management that remove runoff from a site by quickly conveying flows to a storm drain network are also effective in protecting life and property and should be implemented in tandem with low impact design principles. Within Utah, discharges are typically limited to between 0.1 cfs and 0.2 cfs per acre.

An LID approach to site development produces a hydrologic condition that more closely mimics the pre-development hydrologic condition. Peak flows are reduced and are less frequent (*Figure 10*); runoff volume is also reduced (WEF Press, 2012).

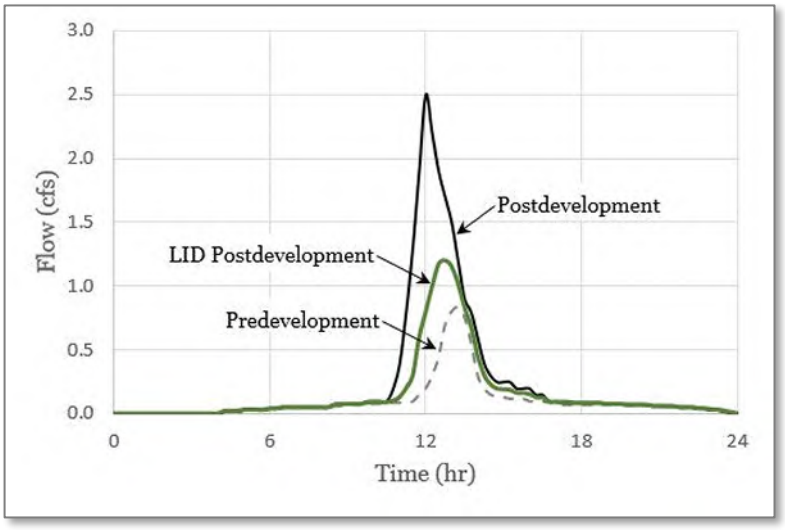


Figure 10: General post development hydrograph with LID.

Developing the 80th Percentile Volume

Project Volume Retention Goal, V_{goal}

V_{goal} for New Development: The volume of runoff generated within the project's limits of disturbance over a 24-hour period during the 80th percentile storm event or a predevelopment condition, whichever is less.

V_{goal} for Redevelopment: For a redevelopment project that results in a net increase in impervious surface greater than 10%, V_{goal} is the net increase in volume between the existing condition and the proposed condition generated by the 80th percentile storm event over a 24-hour period.

Water Quality Volume, WQV – The volume of runoff generated within a BMP's drainage area over a 24-hour period during the 80th percentile storm event.

The following steps may be used to determine the project volume retention goal and the water quality volume.

Step 1: 80th Percentile Depth

Method 1

A table of 80th percentile storm depths can be found in *Appendix A*. These values have been determined by the permittees.

Method 2

Planners and developers should verify with the MS4 before determining an 80th percentile with this method.

Determine the 80th percentile precipitation depth.

1. Obtain long-term daily rainfall data from the following sources:
    a. National Oceanic and Atmospheric Administration (NOAA): https://www.ncdc.noaa.gov/cdo-web/datatools/selectlocation; or
    b. Reliable historical local data; or
    c. Any other reliable data source.
2. Sort data low to high.
3. Remove snowfall and small precipitation events (≤0.1 inch).
4. Use the Excel PERCENTILE function to calculate the 80th percentile rainfall depth.

A more in-depth discussion on determining the 80th percentile precipitation depth is found here: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2019-004584.pdf.

A reliable record of historical precipitation data should meet the following conditions:

1. Come from an active rain gage;
2. Have at least 30 years of data;
3. Have 90% data coverage for the period of record.

Step 2: Imperviousness

To determine the project's volume retention goal, determine the imperviousness within the disturbance limits of the project. To determine the water quality volume of a BMP's drainage area, determine the imperviousness of the drainage area. The imperviousness of the BMP drainage area will include any off-site impervious areas that are part of the BMP's drainage area.

Project imperviousness = Post-development impervious area / Project's disturbance limits

BMP imperviousness = Post-development impervious area within BMP drainage area / BMP drainage area

Step 3: Volumetric Runoff Coefficient

Determine the volumetric runoff coefficient (R_V).

The volumetric runoff coefficient (also referred to as just the 'runoff coefficient') is a calculation of the percentage of rainfall that results in surface runoff. Runoff coefficients for small, frequent storms, such as for the 80th percentile, are not equivalent to runoff coefficients for large, less-frequent storms such as the 10-yr event and greater that are used with the Rational Method. The effects of infiltration, retention, and interception are increased for the smaller storm events compared to the larger events. Because of this, runoff coefficients for smaller storms are numerically smaller than for larger storms.

In 1983 data from over 50 sites nationwide was evaluated as part of the Nationwide Urban Runoff Program (NURP) (Driscoll, 1983). From these sites, mean and median R_V values were calculated and compared to the site's imperviousness. This research led to the following conclusions that are also discussed by Schueler who did additional analysis of the NURP sites:

1. "Most of the variation in mean R_V among sites can be attributed to differences in the level of urbanization, and in particular, to the site imperviousness."
2. "R_V's were found to be relatively consistent at individual sites and were only weakly correlated with storm-related variables such as precipitation volume, intensity, and duration."
3. "The runoff coefficient could serve as a reliable estimator of runoff volumes, given an initial estimate of rainfall volume." (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987)

Various coefficients for smaller storms have also been developed using national datasets and through local research. Municipalities are encouraged to research these and other runoff coefficients or develop their own in determining which method to use within their jurisdiction for use with the 80th percentile storm. Deciding on a single runoff coefficient methodology for a jurisdiction will simplify the design and review process.

Development of a runoff coefficient is done by monitoring the runoff volume produced from a storm event. The runoff coefficient is the ratio between the monitored runoff volume and the total precipitation volume expressed in the following equation and will vary depending on land use and imperviousness of the measured area:

$$R_V = \frac{V_R}{V_P}$$

Where:

R_V = Volumetric runoff coefficient, unitless

V_R = Monitored runoff volume, cf

V_P = Total precipitation volume, cf

The total precipitation volume can be determined using the following equation:

$$V_P = \frac{dA}{12}$$

Where:

d = Precipitation depth, in.

A = Drainage area, sf

It is not the intent of this manual or the Division of Water Quality to recommend specific methodologies. An in-depth summary of runoff coefficients used throughout the country by municipalities and DOTs was developed by the California Department of Transportation (Caltrans) and published as a Technical White Paper titled *Runoff Coefficient Evaluation for Volumetric BMP Sizing*. It can be found here: http://www.dot.ca.gov/design/hsd/guidance/CTSW-TM-15-312_03_01-Runoff_Coeff_for_Vol_BMP_Sizing.pdf. This white paper specifically discusses Method 1 in more detail.

For all the equations presented below, i represents the percent of imperviousness of the drainage area in decimal format (0.0 – 1.0).

Method 1 – Reese method

Comparing the imperviousness of 44 nationwide sites to their respective calculated volumetric runoff coefficient, a simple linear regression equation was created to estimate the volumetric runoff coefficient for small urban catchments. Land uses for these sites were classified as residential, mixed, commercial, industrial, and urban open and nonurban (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987). Outliers were removed from this dataset by Reese to derive the equation below. Removing outliers from the dataset reduces the impact of erroneous measurements (Reese, 2006).

$R_V = 0.91i - 0.0204$

Method 2 – Hydrologic soil groups

Regression equations for runoff coefficient equations were derived based on imperviousness and the NRCS hydrologic soil groups for the 2-year event as presented in *Table 5* (Guo, 2013).

Table 5: Runoff coefficient equations based on the NRCS Soil Group.

NRCS Soil Group		
A	B	C/D
$R_{V\text{-}A} = 0.84i^{1.302}$	$R_{V\text{-}B} = 0.84i^{1.169}$	$R_{V\text{-}C/D} = 0.83i^{1.122}$

Method 3 – Granato method

This runoff coefficient is calculated based on a two-line regression model of the runoff coefficient developed by the United States Geological Survey (USGS). This method of developing the runoff coefficient was developed to assist DOTs and contractors to estimate long-term volume reduction for highway projects and has been adopted for use by UDOT. Additional information relating to this runoff coefficient and its applicability can be found in NCHRP Report 792.

$R_V = 0.225i + 0.05$; when $i < 0.55$

$R_V = 1.14i - 0.371$; when $i \geq 0.55$

Step 4: 80th Percentile Volume

Calculate the 80th percentile volume using the following equations for V_{goal} or WQV.

$$V_{goal} = R_V dA \quad \text{or} \quad WQV = R_V dA$$

Where:

V_{goal} and WQV = 80th percentile volume, cf

R_V = Volumetric runoff coefficient, unitless

d = 80th percentile storm depth, ft (convert from inches to feet if required)

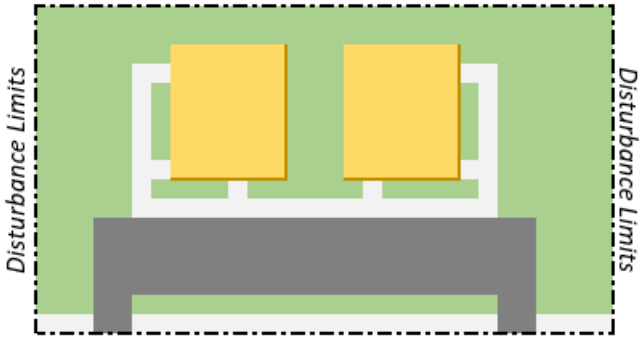
A = Project area or BMP drainage area, sf

The images on the following page show how V_{goal} and WQV are related. Examples from local case studies and different land uses further demonstrate the usage of these equations. See *Land Use Examples* and *Local Case Studies*.

V_{goal}

New Development

V_{goal} is the volume generated from the 80th percentile storm event over the entire project site or a predevelopment hydrologic condition, whichever is less.



$V_{goal} = R_V dA$

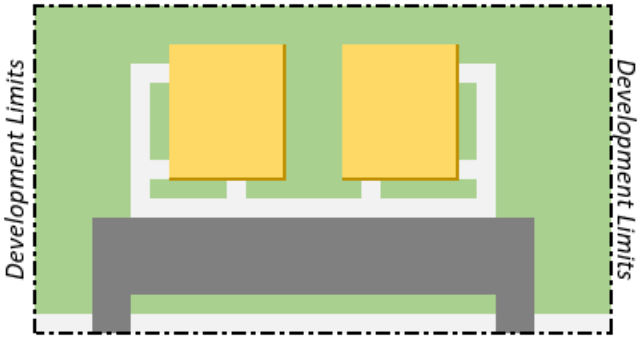
R_V = Volumetric runoff coefficient (based on the project's total area)

d = 80th percentile storm depth, ft

A = Project area, sf

Redevelopment

V_{goal} is the net volume increase generated from the 80th percentile storm event over the project area when the increase in impervious surface is greater than 10%.



Proposed Redevelopment
(Impervious surface increase > 10%)



$V_{goal} = V2 - V1$

$V_2 = R_V dA$

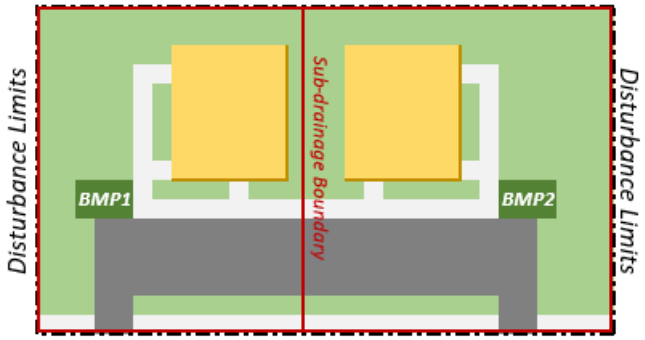
- Volume generated by the 80th percentile storm depth for the proposed project condition.

$V_1 = R_V dA$

- Volume generated by the 80th percentile storm depth for the existing project condition.

Water Quality Volume, WQV

The WQV is the 80th percentile volume of the sub-drainage area for each BMP.



Within the sub-drainage area boundaries, WQV is the 80th percentile volume based on the BMP's drainage area, the imperviousness of the BMP's drainage area, and the 80th percentile storm depth.

$WQV = R_V dA$

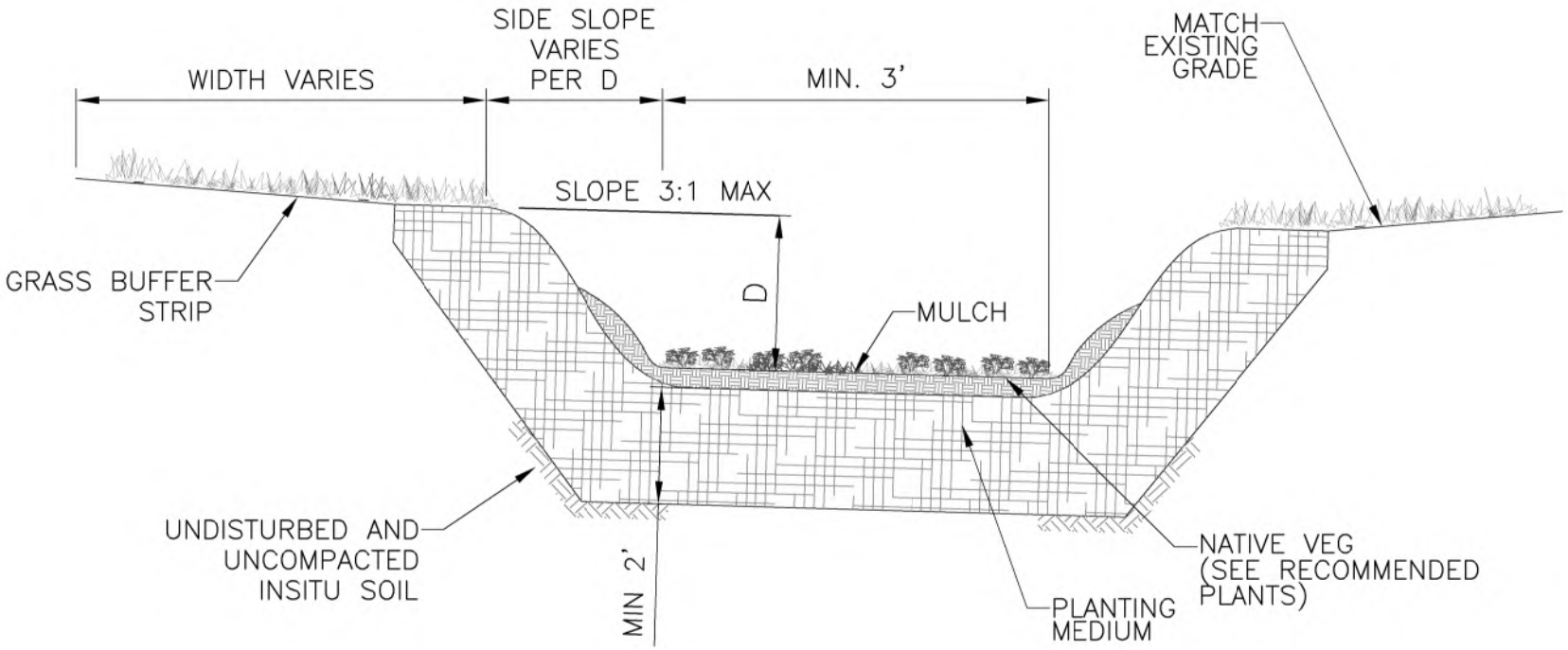
R_V = Volumetric runoff coefficient (based on the sub-drainage area's imperviousness)

d = 80th percentile storm depth, ft

A = Sub-drainage area, sf

Appendix F

(UCEA LID Details)



CALL BLUESTAKES
@ 1-800-662-4111 AT LEAST 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION

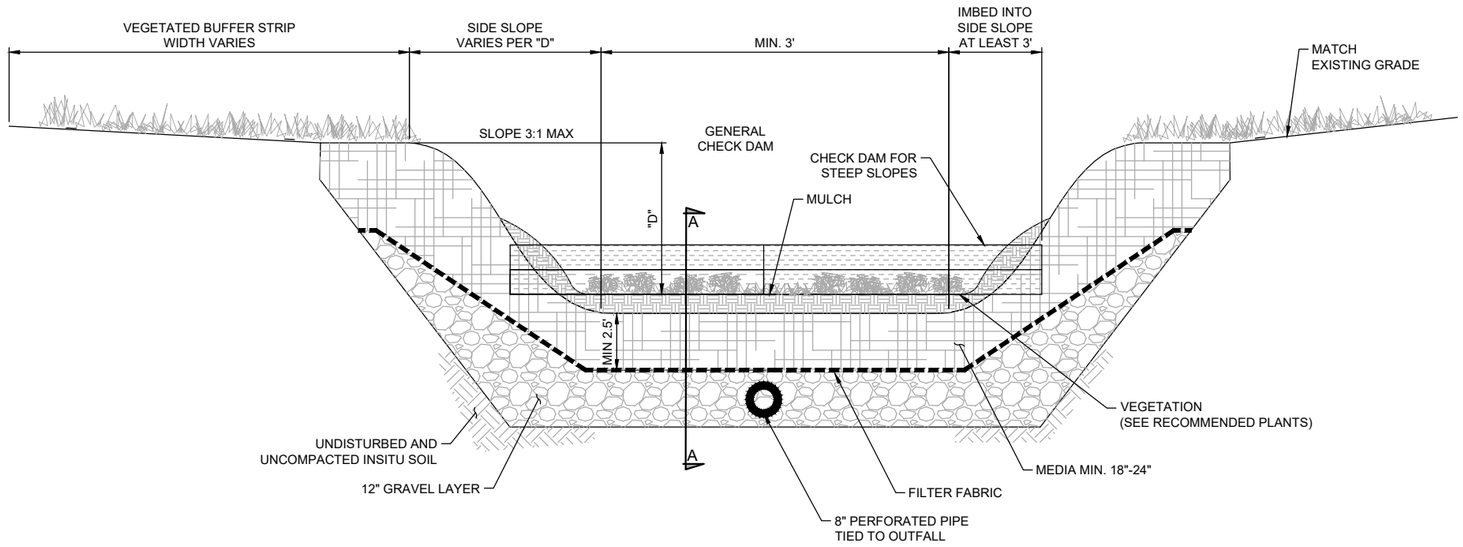
UCEA
UTAH CITY ENGINEERS ASSOCIATION

TYPICAL WET SWALE CROSS-SECTION

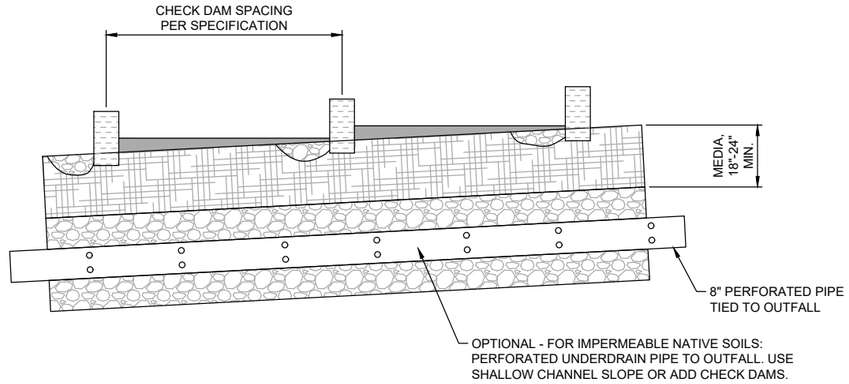
01_LID_StormwaterBMP_WetSwales

REVISIONS			
REV	DATE	BY	

DESIGNED UCEA	DATE 12/31/19	PROJECT NO. LID_01
DRAWN UCEA	DATE 12/31/19	SHEET NO. LID_01
CHECKED UCEA	DATE 12/31/19	DRAWING NO. LID_01



DRY SWALE SECTION



SECTION A

NOTE:

THIS DETAIL IS A MODIFIED VERSION OF UCEA STANDARD DRAWING.

XX / XX — TYPICAL DRY SWALE

03_LID_StormwaterBMP_Dry

REV	DATE	BY	DESCRIPTION

REVISIONS

SCALE

HORIZONTAL 1" = 2'

VERTICAL NONE

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

HORROCKS ENGINEERS

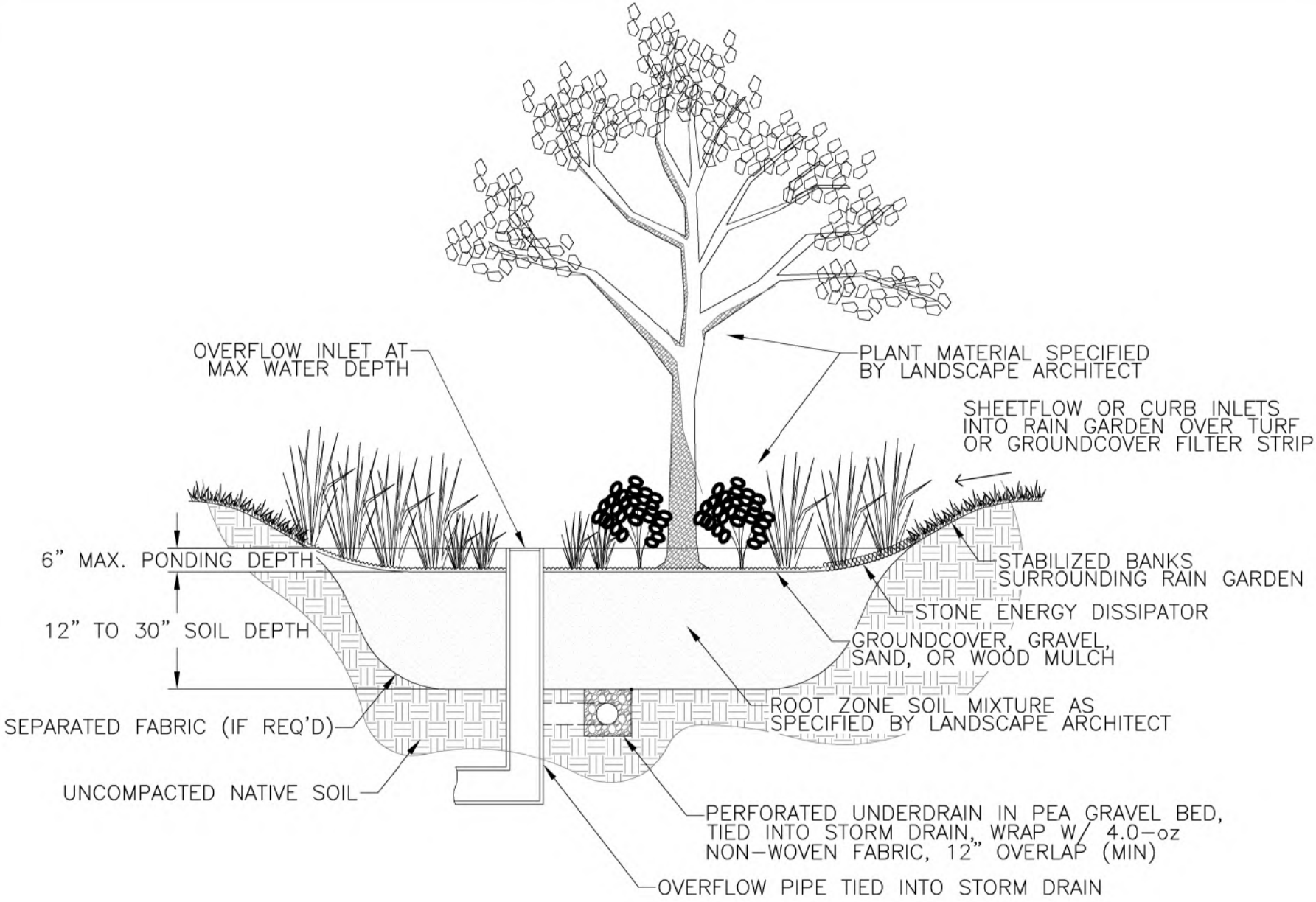
2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

####

####

DESIGNED	DATE	PROJECT NO.
####	####	####
DRAWN	DATE	SHEET NO.
####	####	#### OF ####
CHECKED	DATE	DRAWING NO.
####	####	01

H:\Heber City\City Projects\2020 North Village Master Plan\Storm Drain\Storm Drain Manual\Updated BMP Drawings\TYP DRY SWALE DETAILS.dwg - 01 - 5/11/2022 4:22 PM - lisa]



CALL BLUESTAKES @ 1-800-662-4111 AT LEAST 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION

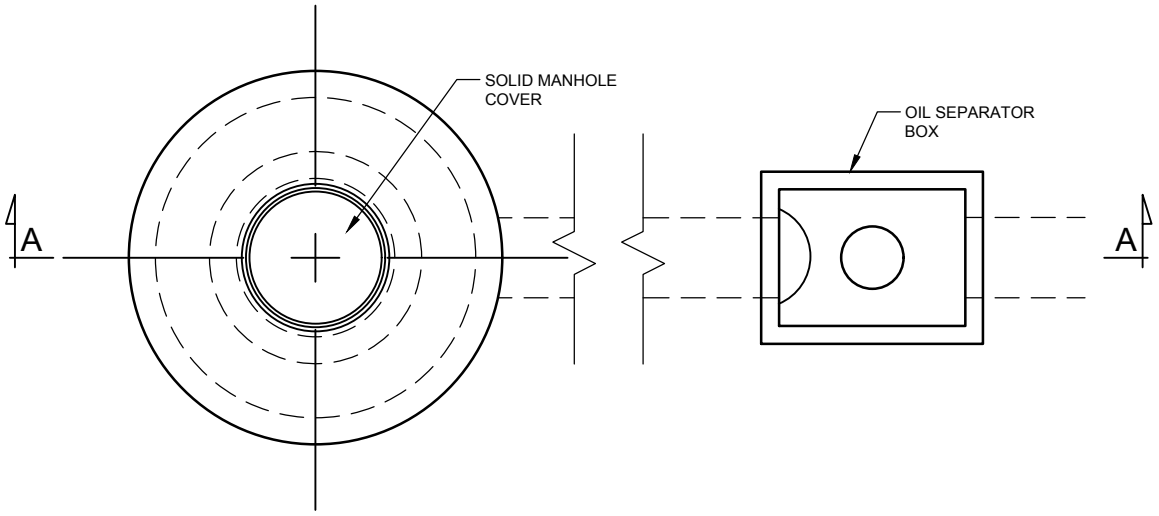
UCEA UTAH CITY ENGINEERS ASSOCIATION

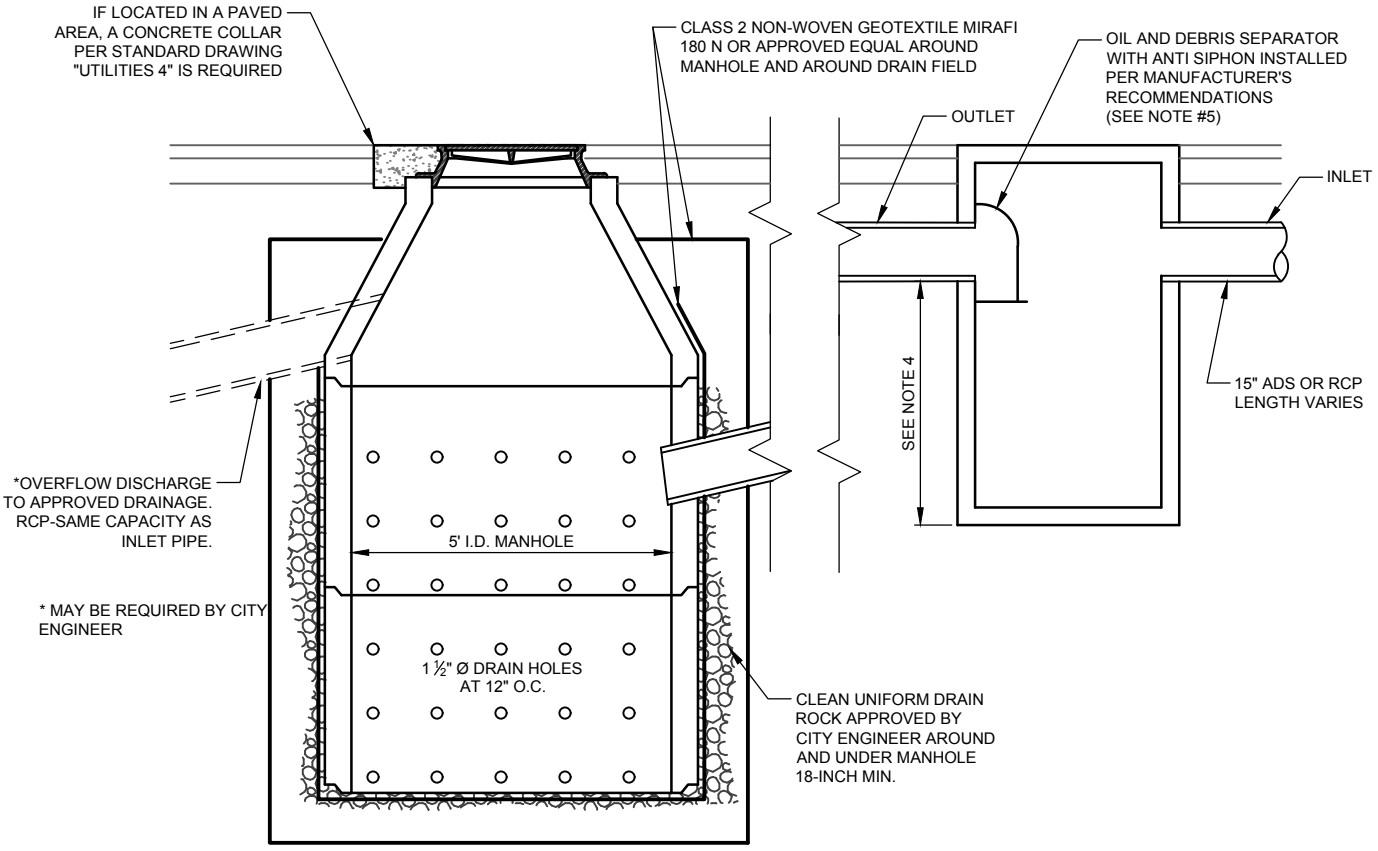
RAIN GARDEN

05_LID_StormwaterBMP_Rain_Garden

REVISIONS			
REV	DATE	BY	

DESIGNED UCEA	DATE 12/31/19	PROJECT NO. LID_05
DRAWN UCEA	DATE 12/31/19	SHEET NO. LID_05
CHECKED UCEA	DATE 12/31/19	DRAWING NO. LID_05





SECTION A-A

NOTES:

1. CONSTRUCT DROP INLET BOX TO MATCH WIDTH OF CURB & GUTTER. MATCH INSIDE LENGTH OF BOX TO INSIDE LENGTH OF FRAME.
2. D & L I-3516 WITH ADJUSTABLE CURB BOX.
3. STANDARD CAST IRON MANHOLE RING & LID.
4. SUMP DEPTH = 36" MIN. FOR 12" DIAMETER OUTLET AND SMALLER, FOR OUTLET DIAMETER 15" AND LARGER, DEPTH = 2.5 TO 3 TIMES THE DIAMETER.
5. SEE STANDARD SPECIFICATION 02772 PONDS.

SUMP DISPOSAL & OIL SEPARATOR

HORROCKS ENGINEERS
728 WEST 100 SOUTH #2
HEBER CITY, UTAH 84032
(435) 654-2226

DATE: FEBRUARY 2019
SCALE: N.T.S.

75 NORTH MAIN STREET
HEBER CITY, UTAH 84032
(435) 654-0757

HEBER CITY
HEART OF THE WASATCH BACK

HEBER CITY STANDARD DRAWING

STORM DRAIN-3

V:\ENGR\Stds\StdSpec\StdSpec 2019\Dwg Files\STORM DRAIN-3.dwg - Sump Oil - 2/06/2019 11:30am, rfunk

Appendix G

(TR-55 Worksheets)

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☐ acres ☐ mi^2 ☐ %	Product of CN x area
	Totals ➡					

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; **Use CN** ➡ ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q	in			

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID	
1. Surface description (table 3-1)		
2. Manning's roughness coefficient, n (table 3-1)		
3. Flow length, L (total L † 300 ft) ft		
4. Two-year 24-hour rainfall, P_2 in		
5. Land slope, s ft/ft		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr		+ =

Shallow concentrated flow

	Segment ID	
7. Surface description (paved or unpaved)		
8. Flow length, L ft		
9. Watercourse slope, s ft/ft		
10. Average velocity, V (figure 3-1) ft/s		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		+ =

Channel flow

	Segment ID	
12. Cross sectional flow area, a ft^2		
13. Wetted perimeter, p_w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15 Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18. ~~Flow~~ length, L ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		+ =
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr		

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = _____ mi^2 (acres/640)

Runoff curve number .....CN = _____ (From worksheet 2)

Time of concentration ..... T_c = _____ hr (From worksheet 3)

Rainfall distribution ..... = _____ (I, IA, II III)

Pond and swamp areas sprea
throughout watershed ..... = _____ percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr			
3. Rainfall, P (24-hour) ..... in			
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)			
5. Compute I_a / P			
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)			
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6			
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)			
9. Peak discharge, q_p ..... ft^3/s			

(Where $q_p = q_u A_m Q F_p$)

Worksheet 5a: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr rainfall P (in)	Runoff curve number CN	Runoff Q (in)	$A_m Q$ (mi^2—in)	Initial abstraction I_a (in)	I_a/P

From worksheet 3 | From worksheet 2 | From table 5-1

Worksheet 5b: Basic watershed data

Project	Location	By	Date
Check one: ☐ Present ☐ Developed	Frequency (yr)	Checked	Date

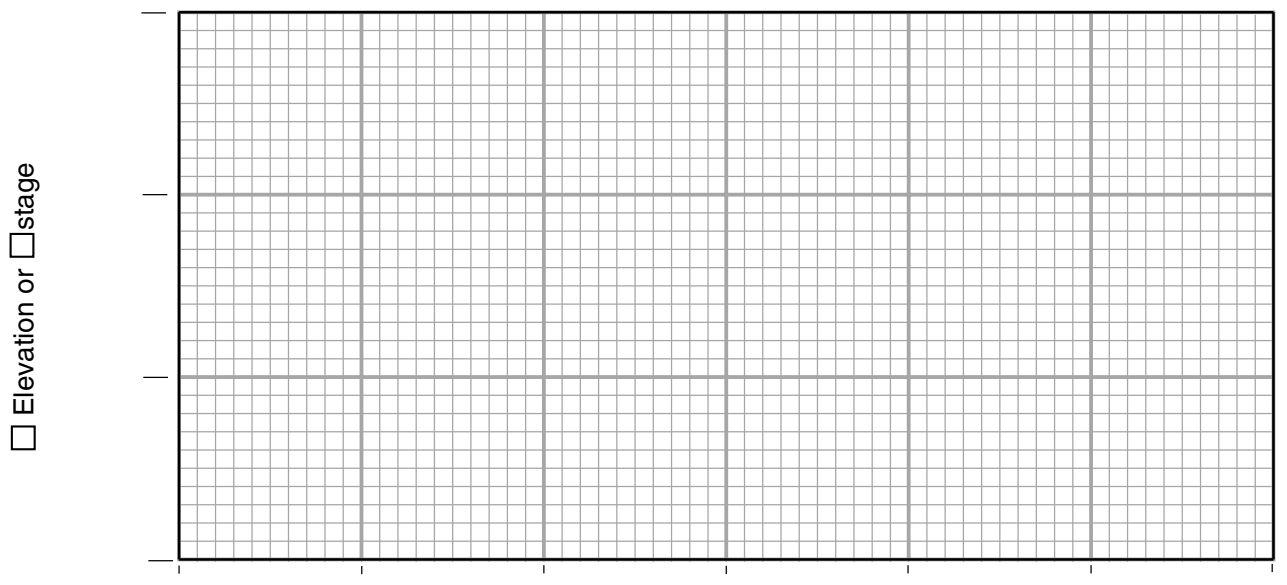
Subarea name	Basic watershed data used 1/				Select and enter hydrograph times in hours from exhibit 5-II 2/											
	Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	A_mQ (mi^2—in)	Discharges at selected hydrograph times 3/ (cfs)											
Composite hydrograph at outlet																

1/ Worksheet 5a. Rounded as needed for use with exhibit 5.
2/ Enter rainfall distribution type used.
3/ Hydrograph discharge for selected times is A_mQ multiplied by tabular discharge from appropriate exhibit 5.

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area ..... A_m = _____ mi^2
   Rainfall distribution type (I, IA, II, III) = _____

	1st Stage	2nd Stage
2. Frequency ..... yr		
3. Peak inflow discharge q_i ..... ft^3/s (from worksheet 4 or 5b)		
4. Peak outflow discharge q_u ..... ft^3/s		1/
5. Compute $\frac{q_o}{q_i}$		

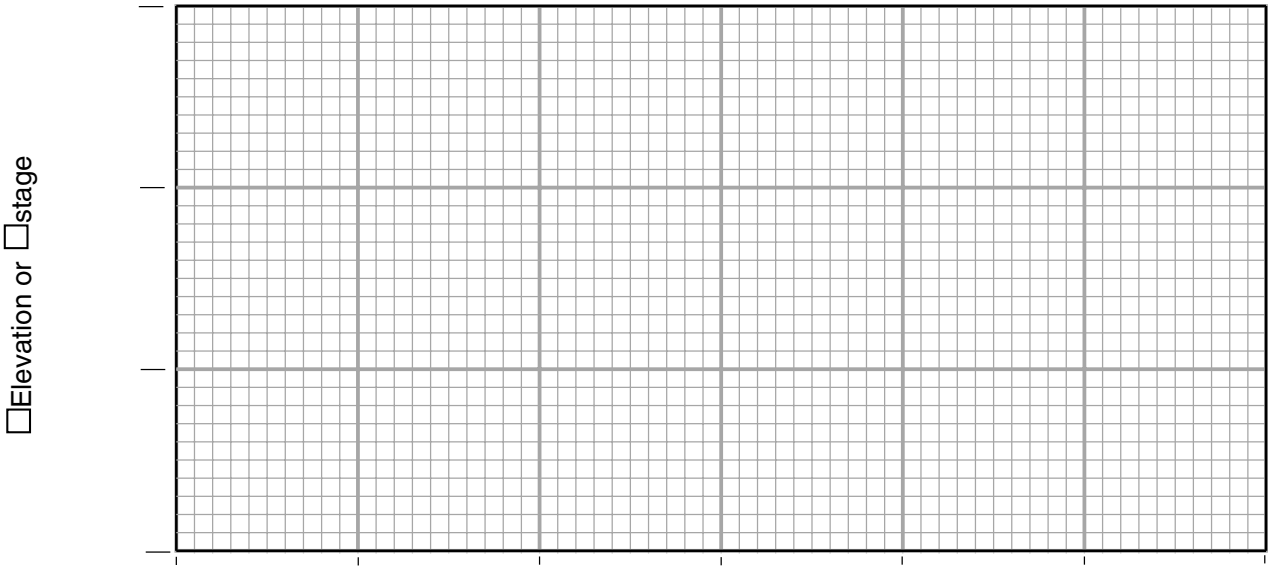
6. $\frac{V_s}{V_r}$ ..... (Use $\frac{q_o}{q_i}$ with figure 6-1)
7. Runoff, Q ..... in (From worksheet 2)
8. Runoff volume V_r..... ac ft ($V_r = QA_m$ 53.33)
9. Storage volume, V_s ..... ac-ft
   ($V_s = V_r \left(\frac{V_s}{V_r}\right)$)
10. Maximum storage E_{max} (from plot)

1/ 2nd stage q_o includes 1st stage q_o.

Worksheet 6b: Detention basin storage, storage volume (V_s) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area ..... A_m = _____ mi^2
   Rainfall distribution type (I, IA, II, III) = _____

	1st Stage	2nd Stage
2. Frequency ..... yr		
3. Storage volume V_s ..... ac-ft		
4. Runoff, Q ..... in (from worksheet 2)		
5. Runoff volume ..... ac-ft ($V_r = QA_m$ 53.33)		

1/ 2nd stage q_o includes 1st stage q_o.

6. Compute $\frac{V_s}{V_r}$ .....

7. $\frac{q_o}{q_i}$ ..... in
   (Use $\frac{V_s}{V_r}$ with figure 6-1)

8. Peak inflow discharge q_i ..... in
   (From worksheet 4 or 5b)

9. Peak outflow discharge q_o ..... ft^3/s 1/
   ($q_o = q_i$ ($\frac{q_o}{q_i}$))

10. Maximum storage E_{max} (from plot)

Appendix H

(Source Protection Maps)

Legend

- Broadhead Spring
- Fuel Tank
- Animal Feeding
- Golf Course
- Red Ledges Yard
- Septic System
- Other Wells

Broadhead Springs Zones

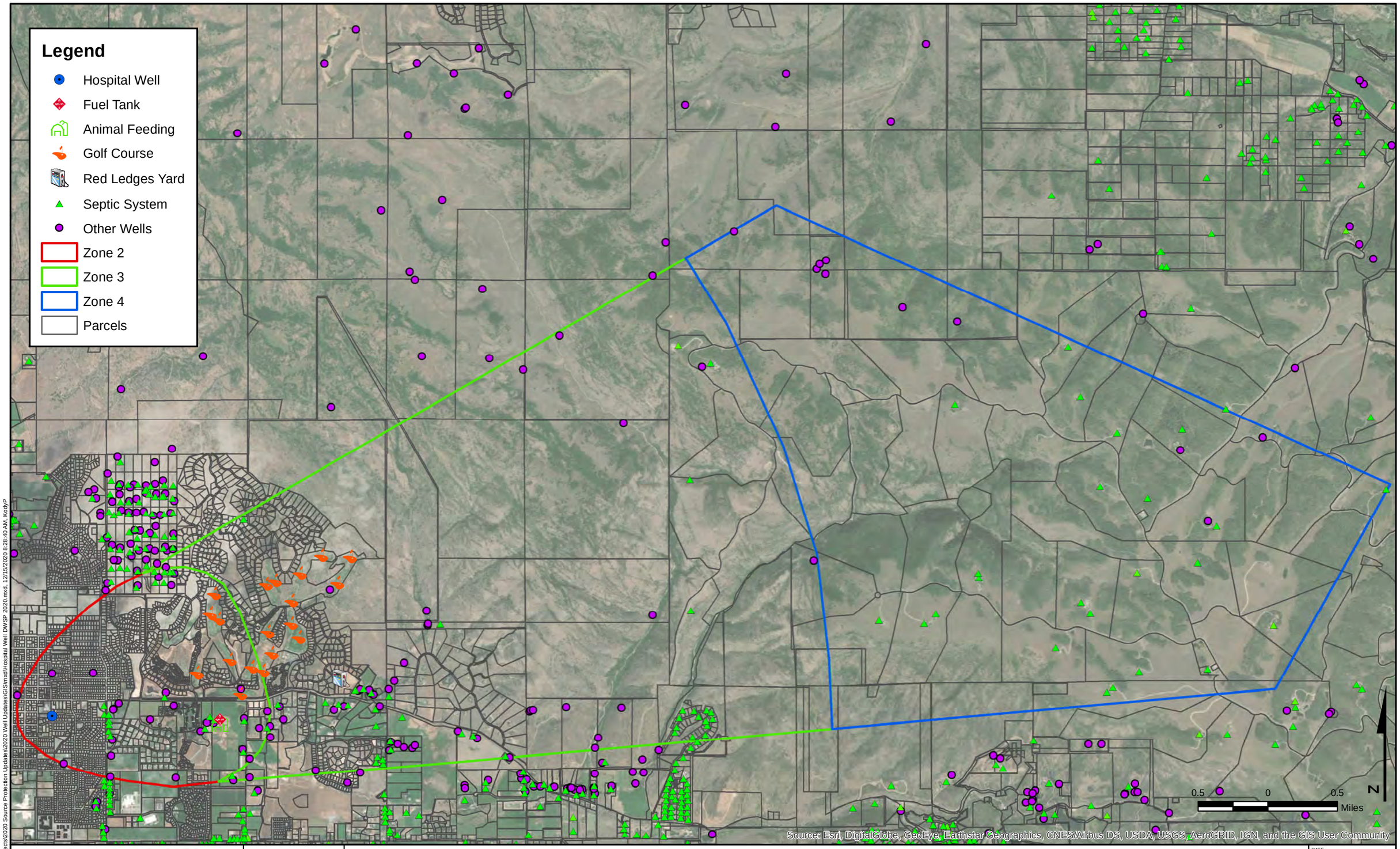
- Zone 2
- Zone 3
- Zone 4
- Parcels

HORROCKS ENGINEERS
2162 West Grove Parkway, Suite #400
Pleasant Grove, UT (801) 763-5100

Broadhead Springs Delineation Zones & PCS's

N
W E
S

1:36,000



H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Hospital Well DWSP 2020.mxd, 12/15/2020 8:28:40 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

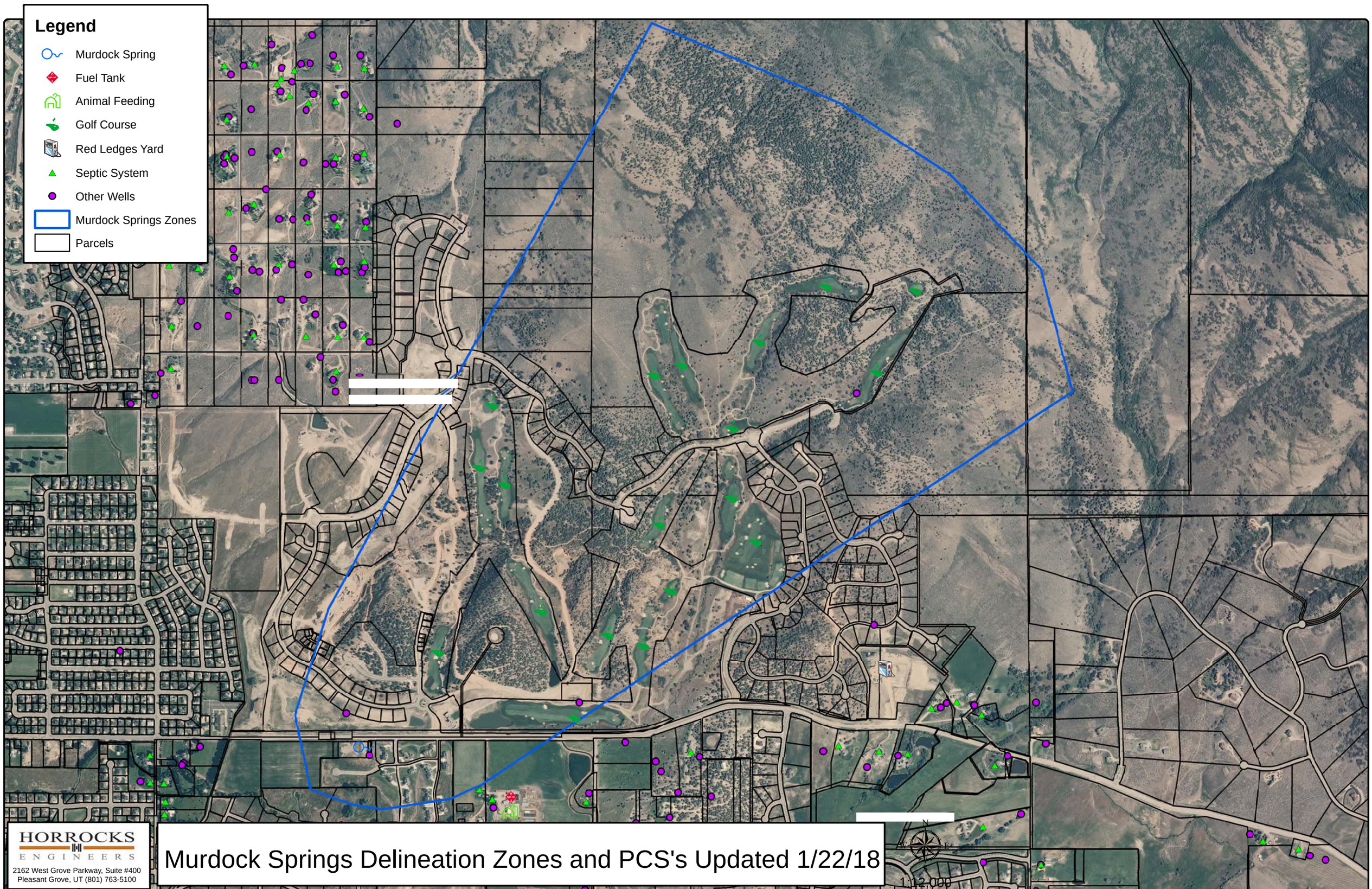
Hospital Well Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

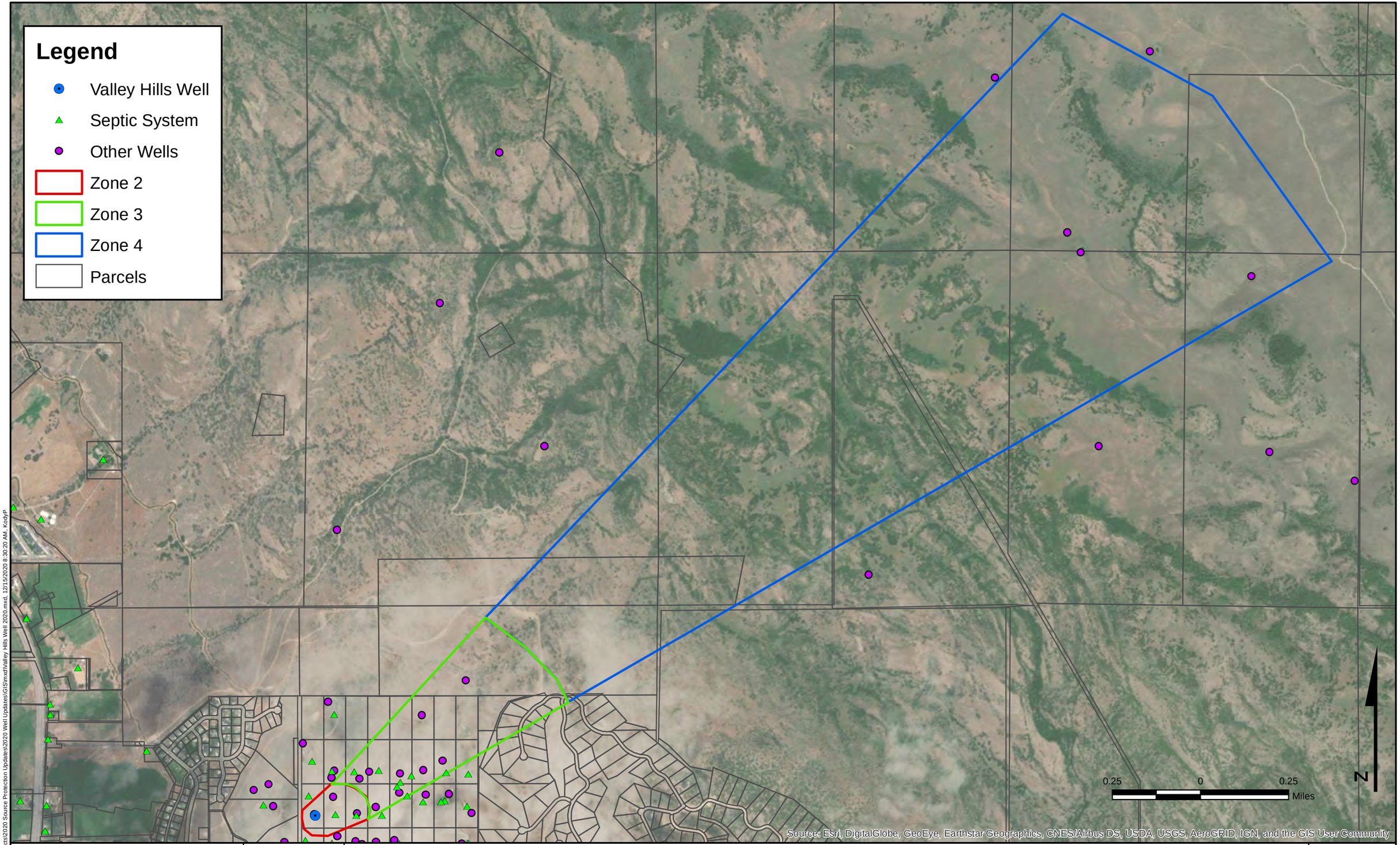
DRAWN

Figure 1



Murdock Springs Delineation Zones and PCS's Updated 1/22/18

HORROCKS ENGINEERS
2162 West Grove Parkway, Suite #400
Pleasant Grove, UT (801) 763-5100



H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Valley Hills Well 2020.mxd, 12/15/2020 8:30:20 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

Valley Hills Well Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

DRAWN

Figure 2

Legend

- Well #1
- Fuel Tank
- Animal Feeding
- Golf Course
- Red Ledges Yard
- Septic System
- Other Wells
- Zone 2
- Zone 3
- Zone 4
- Parcels

0.5 0 0.5 Miles

N

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

H:\Heber City\City Projects\2020 Source Protection Updates\2020 Well Updates\GIS\mxd\Well #1 2020.mxd, 12/15/2020 8:35:43 AM, KodyP

HORROCKS ENGINEERS

728 West 100 South #2
Heber City, UT 84032
(435) 654-2226

Well #1 Delineation Zones & PCS's

2020 DWSP Update

DATE 12/15/2020

DRAWN

Figure 3

Appendix I

(FAA Method Storage Facility Volume)

Obtain Excel file from City

Detention Pond Design
FAA Method with Guo Parameter

Runoff Coefficients		
Surface Type	Area	C
Hardscape	123805	0.9
Roof	56760	0.9
Landscape	83409	0.44
	263974	

Orifice Sizing		
Discharge	0.98	cfs
Head	4	ft
Orifice Coeff.	0.61	
Diameter	4.28	in

Basin Parameters		
Total Basin Area (A) =	9.8	acres
Connected Basin Area (A) =	6.06	acres
Weighted Coefficient (C) =	0.75	
Release Rate =	0.1	cfs/acre
Time of Concentration (tc) =	15	minutes

Pipe Volumes		
I.D. (in.)	Length	Vol. (cf)
0	0	0
0	0	0
		0

Time (min)	100-yr Rainfall (in)	100-yr Rainfall Intensity (in/hr)	Inflow Volume (cf)	Adjustment Factor	Outflow (cfs)	Outflow Volume (cf)	100-yr Required Detention Volume (cf)
5	0.54	6.52	9014	1.00	0.98	294	8720
10	0.83	4.96	13729	1.00	0.98	588	13141
15	1.02	4.08	16933	1.00	0.98	882	16051
20	1.14	3.42	18925	0.88	0.86	1029	17896
25	1.26	3.02	20917	0.80	0.78	1176	19741
30	1.38	2.76	22909	0.75	0.74	1323	21586
35	1.44	2.46	23822	0.71	0.70	1470	22352
40	1.49	2.24	24735	0.69	0.67	1617	23118
45	1.55	2.06	25648	0.67	0.65	1764	23884
50	1.60	1.92	26561	0.65	0.64	1911	24650
55	1.66	1.81	27474	0.64	0.62	2058	25416
60	1.71	1.71	28387	0.63	0.61	2205	26182
65	1.73	1.59	28678	0.62	0.60	2352	26326
70	1.75	1.50	28968	0.61	0.60	2499	26469
75	1.76	1.41	29259	0.60	0.59	2646	26613
80	1.78	1.34	29549	0.59	0.58	2793	26756
85	1.80	1.27	29840	0.59	0.58	2940	26900
90	1.82	1.21	30130	0.58	0.57	3087	27043
95	1.83	1.16	30421	0.58	0.57	3234	27187
100	1.85	1.11	30711	0.58	0.56	3381	27330
105	1.87	1.07	31002	0.57	0.56	3528	27474
110	1.89	1.03	31292	0.57	0.56	3675	27617
115	1.90	0.99	31583	0.57	0.55	3822	27761
120	1.92	0.96	31873	0.56	0.55	3969	27904
125	1.92	0.92	31902	0.56	0.55	4116	27786
130	1.92	0.89	31930	0.56	0.55	4263	27667

Simplied Rational Method Pond Sizing Template Calculation for 25-year Storm Event

Drainage areas	Sq. Ft	C Value
buildings	1	0.95
Aspahlt	1	0.95
Grass	1	0.15
Gravel	1	0.65
Concrete	1	1.00
Total	**5**	
Weighted C	0.740	
Infiltration min/in	1	
Safety Factor (2 minimum)	2	
Infiltration ft/min	0.0417	
Discharge per Acre (cfs) (Max=0.1)	0.1000	

25-yr Storm		
	in.	in/hr
5	0.36	4.36
10	0.55	3.32
15	0.69	2.74
30	0.92	1.85
60	1.14	1.14
120	1.31	0.65
180	1.38	0.46
360	1.62	0.27
720	1.97	0.16
1440	2.36	0.10

Mannings Calculation Spreadsheet			
Pipe D (in)	S (in/in)	n	
15	0.008	0.013	
V =	**4.72** ft/s		
Q =	**5.79** cfs		

Pipe Discharge	
	(cfs)
	0
	0
	0
	0
	0
	0
	0
	0
	0

	Depth (Ft)	Avg Length (Ft)	Avg Width (Ft)	Capacity (CF)
Pond Dimension				0
	Diam. (Ft)	**Depth (Ft)**		
Sump Manhole(s) (in the pond)			1	0
Drain Rock Around Sump MH (in pond)				0
Sump Manhole(s) (not in pond)				0
Drain Rock Around Sump MH (not in pond)				0
	Diam. (In)	**Length (Ft)**		
Underground Pipe Storage (no infiltration)				0
	Height (Ft)	**Length (Ft)**	**Avg Width (Ft)**	
Wrapped Drain Rock				0
	Height (Ft)	**Length (Ft)**	**Avg Width (Ft)**	
Underground Storage Chambers and Wrapped Drain Rock				

Drain Rock Void Ratio %	40
Will pond be Landscaped with Topsoil? (Y/N)	N
Will Underground Storage Chambers be under the pond? (Y/N)	N

Total Storage Capacity (CF)	0
Pond Exfiltr Surface (SF) (Must be zero if pond is landscaped with topsoil)	0
Underground Exfiltration Surfaces (SF)	0
Total Exfiltration Surface (SF)	0

Time (min)	Accum. Vol (CF)	Exfiltration (CF)	Discharge (CF)	Storage Req. (CF)	Max (CF)
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
30	0	0	0	0	0
60	0	0	0	0	0
120	0	0	0	0	0
180	0	0	0	0	0
360	0	0	0	0	0
720	1	0	0	0	0
1440	1	0	1	0	0
				Ultimate Demand	**0**

System is **Not Ok**

Notes:
Exfiltration from pond only allowed if the pond is not landscaped with topsoil. Only the bottom surface area of the pond may be used in exfiltration calculation.

Simplied Rational Method Pond Sizing Template Calculation for 100-yr Storm Event

Drainage areas	Sq. Ft	C Value
buildings	1	0.95
Aspahlt	1	0.95
Grass	1	0.15
Gravel	1	0.65
Concrete	1	1.00
Total	**5**	
Weighted C	0.740	
Infiltration min/in	1	
Safety Factor (2 minimum)	2	
Infiltration ft/min	0.0417	
Discharge per Acre (cfs) (Max=0.1)	0.1000	

100-yr Storm		
	in.	in/hr
5	0.54	6.49
10	0.82	4.94
15	1.02	4.08
30	1.37	2.75
60	1.70	1.70
120	1.91	0.96
180	1.94	0.65
360	2.12	0.35
720	2.52	0.21
1440	2.97	0.12

Mannings Calculation Spreadsheet			
Pipe D (in)	S (in/in)	n	
15	0.008	0.013	
V =	**4.72** ft/s		
Q =	**5.79** cfs		

Pipe Discharge	
	(cfs)
	0
	0
	0
	0
	0
	0
	0
	0
	0

	Depth (Ft)	Avg Length (Ft)	Avg Width (Ft)	Capacity (CF)
Pond Dimension				0

	Diam. (Ft)	Depth (Ft)	Quanity	
Sump Manhole(s) (in the pond)			1	0
Drain Rock Around Sump MH (in pond)				0
Sump Manhole(s) (not in pond)				0
Drain Rock Around Sump MH (not in pond)				0

	Diam. (In)	Length (Ft)	
Underground Pipe Storage (no infiltration)			0

	Height (Ft)	Length (Ft)	Avg Width (Ft)	
Wrapped Drain Rock				0

	Height (Ft)	Length (Ft)	Avg Width (Ft)	
Underground Storage Chambers and Wrapped Drain Rock				

Drain Rock Void Ratio %	40
Will pond be Landscaped with Topsoil? (Y/N)	N
Will Underground Storage Chambers be under the pond? (Y/N)	N

Total Storage Capacity (CF)	0
Pond Exfiltr Surface (SF) (Must be zero if pond is landscaped with topsoil)	0
Underground Exfiltration Surfaces (SF)	0
Total Exfiltration Surface (SF)	0

Time (min)	Accum. Vol (CF)	Exfiltration (CF)	Discharge (CF)	Storage Req. (CF)	Max (CF)
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
30	0	0	0	0	0
60	1	0	0	0	0
120	1	0	0	1	1
180	1	0	0	0	1
360	1	0	0	0	1
720	1	0	0	0	1
1440	1	0	1	0	1
				Ultimate Demand	**1**

System is **Not Ok**

Notes:
Exfiltration from pond only allowed if the pond is not landscaped with topsoil. Only the bottom surface area of the pond may be used in exfiltration calculation.

Guo, James C.Y. (1999). "*Detention Basin Sizing for Small Urban Catchments*," ASCE J. of Water Resources Planning and Management, Vol 125, No.6, Nov.

DETENTION BASIN SIZING FOR SMALL URBAN CATCHMENTS

by James C.Y. Guo, *PhD, P.E., Professor,*
Department of Civil Engineering, University of Colorado at Denver, Denver, Colorado.

Abstract
The Federal Aviation Administration (FAA) method for sizing small detention and retention basins is a volume-based approach that is sensitive to the release rate. In practice, such a release rate is often approximated by open channel hydraulics or culvert hydraulics. Without a consistent guideline, this practice of approximation can result in significant discrepancy or violation of the volume balance between the inflow and outflow hydrographs. In this study, a consistent procedure was developed to derive the average release from the allowable peak outflow. The required parameters for this method include peak inflow, design storm duration, and the time of concentration of the watershed. With this modification, the detention storage volume maximized by the FAA method can satisfy the volume conservation between hydrographs.

Key Words: Detention, Rational, FAA

INTRODUCTION

Urban stormwater facilities are designed to pass the peak flow through conveyance systems or to store a portion of the runoff volume in detention systems. For a small urban catchment with a tributary area less than 100 acres, the rational method is suitable for peak runoff predictions and the Federal Aviation Administration (FAA) method is recommended for detention storage volume predictions. The FAA's procedure is to maximize the required storage volume by the volume difference between the inflow and outflow volumes produced by a series of rain storms on the watershed. During the optimization process, the outflow volumes are calculated by an approximate average release from the detention basin. In current practice, there is not any guidance as to how to estimate the average release.

As a volume-based method, the FAA procedure has been widely used for small urban catchments in spite of its ambiguity in estimating the average release from the basin. For instance, the average release may be calculated by open channel flow, orifice formula, or culvert hydraulics. These hydraulic approaches result in violation of the hydrologic principle of volume conservation between the inflow and outflow hydrographs and inaccurate calculations on the required detention storage volume. To improve the current practice, this study suggests that the average release be a fraction of the allowable release rate. This fraction can be further derived by the volume conservation principle between inflow and outflow hydrographs during the maximization process. In this study, this ratio was found to vary with respect to storm duration, and is not a constant as recommended in many design criteria such as the Denver Design Criteria Manuals, and FAA Airfield and Heliports Design Criteria. The revised procedure can also be applied to other volume-based methods such as the capture runoff volume method (Guo and Urbonas, 1996) for sizing storm water quality control ponds. It provides a

consistent guideline to the estimation of the average release from a basin, and warrants volume conservation between the inflow and outflow hydrographs.

DETENTION STORAGE VOLUME BY THE FAA METHOD

The volume-based approach such as the FAA method is applicable to urban catchments with a tributary area less than 150 acres. To predict the peak runoff from such a small urban watershed, the Rational method states:

$$Q_d = \alpha C I_d A \tag{1}$$

The rainfall intensity in Eq 1 can be described as:

$$I_d = \frac{aP}{(b + T_d)^n} \tag{2}$$

in which α = unit conversion factor, equal to 1 for English units, and 1/360 for SI units, C = runoff coefficient, A= watershed area in acres (hectare), I_d = rainfall intensity in inch/hr (mm/hr), T_d = rainfall duration in minutes, Q_d= peak runoff rate in cfs (cms) and a, b, and n= constants on the Intensity- Duration- Frequency (IDF) formula.

Storm water detention process is to reduce the peak runoff and to delay the time to peak as well. In practice, the allowable release rate from a basin is defined by the downstream critical capacity, or the pre-development condition.
In this study, the average release is suggested to be a fraction of the allowable peak runoff, Q_a. Therefore, we have:

$$Q_m = mQ_a \tag{4}$$

in which Q_a = the allowable release which occurs at time T_a in Figure 1, Q_m = average release rate, and m = ratio of the average release to the allowable peak runoff rate. For a storm event, the detention storage volume is equal to the volume difference of the inflow and outflow as:

$$V_i = \alpha C I_d A T_d \tag{5}$$

$$V_o = Q_m T_d = mQ_a T_d \tag{6}$$

$$V_d = 60\left[\alpha C I_d A T_d - Q_m T_d\right] = 60\left[Q_d T_d - Q_m T_d\right] \tag{7}$$

in which V_i = inflow volume, V_o = outflow volume, and V_d = the required storage volume in cubic feet or cubic meter. The factor of 60 is to convert seconds to minutes. The reliability of Eq 7 depends on the specified average outflow in Eq 4. Without an adequate guidance, Eq 7 may lead to any result based on engineer's best estimation. Although an adjustment factor have been recommended to avoid underestimation of the detention volume by Urbonas and Stahle (1991) and Guo (1990), it is necessary to develop a consistent guideline for Eq 4.

MAXIMIZATION OF DETENTION STORAGE VOLUME

The peak runoff flow that occurs at the time of concentration, T_c is recommended for conveyance designs. It is well understood that the design storm duration for a detention basin is usually longer that T_c. As illustrated in Figure 1, the peak flow, Q_d, is produced by the design storm for the detention design. To estimate the required storage volume with no prior knowledge of the outlet hydraulics, it is suggested that the storage volume be calculated using the linear rising outflow hydrograph, i.e. line OB in Figure 1 (Malcom 1982) (Guo 1997). Based on the volume difference between the inflow and outflow hydrographs in Figure 1, the detention storage volume, i.e. the shaded area, is:

$$V_d = 60\left[Q_d T_d - \frac{Q_a}{2}(T_d + T_c) \right] \tag{8}$$

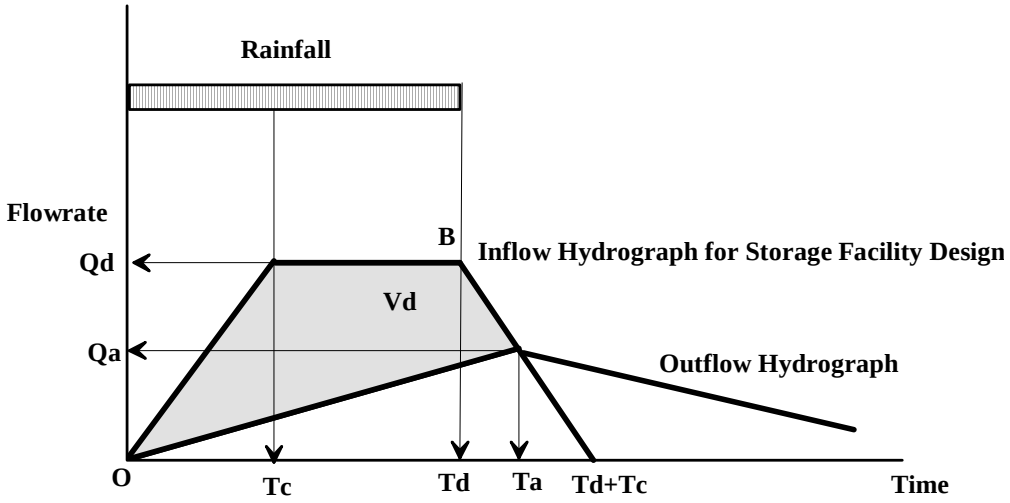


Figure 1. Detention Storage Volume Estimated by Hydrographs

Equating Eq 7 to Eq 8, the value of m is derived as:

$$m = \frac{1}{2}(1 + \frac{T_c}{T_d}) \quad \text{for } 0.5<m<1 \text{ and } T_d > T_c \tag{9}$$

Often the value of m is recommended to be a constant between 0.80 and 0.90 for all storm events (Urbanos and Stahre in 1991). Eq 19 indicates that the value of m varies with respect to the rain storm duration and can not be applied to a storm with duration less than T_c because the maximized operation of a detention basin requires the entire catchment to be tributary. The current practice does not have any limitation on storm duration and results in a maximization procedure starting from 5-minute rainfall. Eq. 9 begins with a value equal to unity when the storm duration is equal to T_c and then reduces to 0.5 when T_d is much longer than T_c. In comparison, the current practice of applying a constant value of m to all storm events can lead

to significant mistake. Substituting Eq 9 into Eq. 5 with the aid of Eq 3, the FAA method is modified to:

$$V_d = 60\left[\alpha C I_d A - \frac{Q_a}{2}(1+\frac{T_c}{T_d})\right]T_d \qquad (10)$$

The basic concept in the FAA method is to find the maximum volume difference between the inflow and outflow volumes under a series of storm events with different durations. Eq 10 shall be tested for a range of T_d until Eq 10 is maximized as:

$$V_m = 60\left[\alpha C I_m A - \frac{Q_a}{2}(1+\frac{T_c}{T_m})\right]T_m \quad \text{at } T_d = T_m \qquad (11)$$

where the subscript m represents the maximized solution.

DESIGN SCHEMATICS AND EXAMPLES

The example watershed used in this study is located in the City of Denver, Colorado. The 100-year IDF in Denver is specified by a = 74.1, b = 10, and n = 0.786. The developed watershed of 100 acres has a time of concentration of 25 minutes and runoff coefficient of 0.65. It produces a 100-year developed peak runoff of 296.86 cfs. The allowable release is 33% of the developed peak runoff. As a result, the allowable release rate is

$$Q_a = 0.33 Q_p = 97.96 \quad cfs \qquad (12)$$

The detention volumes for various periods of storm duration are calculated in Table 1. The maximized volume is found to be 8.52 acre-ft for this example.

Duration	Rainfall Intensity	Inflow Volume	Average Parameter	Average Outflow	Outflow Volume	Storage Volume
minutes	inch/hr	acre-ft	M	cfs	acre-ft	acre-ft
		Eq5	Eq 9	Eq 4	Eq 6	Eq 10
50.00	2.97	13.28	0.75	72.36	4.98	8.30
60.00	2.63	14.12	0.71	68.34	5.65	8.47
70.00	**2.37**	**14.83**	**0.68**	**65.47**	**6.31**	**8.52**
80.00	2.16	15.45	0.66	63.32	6.98	8.47
90.00	1.99	16.00	0.64	61.64	7.64	8.36

Table 1. Example for Maximization of Detention Volume.

CONCLUSIONS

Different hydrologic methods were developed for different hydrologic conditions. In the development of technical design criteria, it is a continual effort to maintain consistency among various design methods. The FAA method intends to be a simplified volume-based approach.

However, the current practice falls short in the estimation of the average outflow. This study presents a modification to the volume-based approach such as the FAA method so that the estimated detention volume can be consistent with the hydrograph method. Modifications to the FAA procedures shall not change its original intention as a simplified approach. As a result, this study applies the volume conservation principle between the simplified hydrographs to relate the average outflow as a fraction of the allowable release rate.

In this study, it was found that the average outflow can be determined by the allowable release from the basin, design storm duration, and the time of concentration of the watershed. In practice, the average release was often considered to be the average flow rate over the base time of the outflow hydrograph. This study indicates that this average outflow in fact is the equivalent average release rate that drains the basin storage volume over the storm duration time. Secondly, the ratio of average release to allowable release was not so constant as recommended by the current practice. Instead, it varies between one and 0.5, depending on storm duration. Applying a constant ratio to all storm events may result in a significant discrepancy against the volume conservation between the inflow and outflow hydrographs. Eq 9 provides a consistent guideline that modifies the current FAA procedures to satisfy the hydrograph volume balance.

APPENDIX I. REFERENCES

1. Adams County, Colorado. (1990) "*Storm Drainage Design and Technical Criteria*."

2. Department of the army and the Air Force. (1977) "*Surface Drainage Facilities for Airfields and Heliports*." Technical Manual No 5-820-1, Washington DC.

3. Federal Aviation Administration, Department of Transportation. (1970) "*Airport Drainage"*, AC No. 150/5320-5B.

4. Guo, James C.Y. (1977). "*Detention Basin Design and Sizing*. " Research Report, Department of Civil Engineering, University of Colorado at Denver, to be published by the Water Resources Publication, Inc. Littleton, Colorado.

5. Guo, James C.Y. and Urbona, Ben. (1996) "*Maximized Detention Volume Determined by Runoff Capture Ratio*." ASCE J. of Water Resources Planning and Management, Vol. 122, No. 1.

6. Malcom, H. Rooney. (1982) "*Some Detention Design Ideals.* " ASCE Proceedings of the Conference on Stormwater Detention Facilities, held in New England College, Hanniker, New Hampshire, edited by William DeGroot.

7. Shueler, Thomas R., and Helfrich, Mike. (1989) "*Design of Extended Detention Wet Pond System.* " Design of Urban Runoff Quality Controls, Edited by Larry A. Roesner, Ben Urbonas, and Michael B. Sonnen, American Society of Civil Engineers, New York, New York.

8. Urbonas, Ben and Stahre, Peter. (1991) "*Storm Water Detention.* " Prentice Hall, Englewood Cliffs, New Jersey.

135	1.93	0.86	31958	0.56	0.54	4410	27548
140	1.93	0.83	31986	0.55	0.54	4557	27429
145	1.93	0.80	32014	0.55	0.54	4704	27310
150	1.93	0.77	32043	0.55	0.54	4851	27192
155	1.93	0.75	32071	0.55	0.54	4998	27073
160	1.93	0.73	32099	0.55	0.54	5145	26954
165	1.94	0.70	32127	0.55	0.53	5292	26835
170	1.94	0.68	32156	0.54	0.53	5439	26717
175	1.94	0.66	32184	0.54	0.53	5586	26598
180	1.94	0.65	32205	0.54	0.53	5733	26472

Appendix J

(Storm Water Maintenance Agreement and Management Plan)

When recorded, mail to:
Heber City Recorder
75 North Main Street
Heber City, Utah 84032

LONG-TERM STORM WATER MAINTENANCE AGREEMENT
(Development Name)

THIS STORM WATER MAINTENANCE AGREEMENT (this "Agreement") is made and entered into this _____ day of _____, 2022, by and between Heber City, a municipal corporation of the State of Utah (the "City"); and _____ ("Owner") whose address is _____ Heber City, Utah 84032.

RECITALS

A. The City is authorized and required to regulate and control the disposition of storm and surface waters within the City, as set forth in the Heber City Code, as amended ("Ordinance"), and as adopted pursuant to the Utah Water Quality Act, as set forth in Utah Code Ann § 19-5-101, er seq., as amended (the "Act").

B. The Owner hereby represents and acknowledges that it is the owner in fee simple or is solely responsible through separate agreement(s) for storm water and its management from certain real properties more particularly described in Exhibit "A", attached hereto and incorporated herein by this reference (the "Property"), and in any amendments thereto, which property is subject to the regulations described above.

C. The Owner desires to build or develop the Property and/or to conduct certain regulated construction activities on the Property which will alter existing storm and surface water conditions on the Property and/or adjacent lands; and

D. To facilitate the anticipated development of the Property, the Owner desires to build and maintain, at Owner's expense, storm and surface water management facilities, including structures, improvements, grading and drainage plans and/or vegetation to control the quantity and quality of the storm water (the "Storm Water Facilities"); and

E. The Storm Water Facilities are shown in the final site plans for subdivisions accepted for the Property, in any related engineering drawings, and in any amendments thereto, which plans, and drawings are on file in the Heber City Engineering Department, and are hereby incorporated herein by this reference (the "Development Plan"); and

F. A detailed description of the Storm Water Facilities, which includes the operation and maintenance procedures required to enable the Storm Water Facilities to perform their designed functions (the "Long-Term Storm Water Management Plan"), is attached hereto as Exhibit "B". This plan is incorporated herein by this reference and may be amended from time to time by the City to comply with City's storm water management plan, MS4 UPDES permit, and other federal, state, and local requirements; and

G. As a condition of Development Plan acceptance, Owner is required to enter into this Agreement establishing a means of operating and documenting the execution of the Long-Term Storm Water Management Plan within the Property.

AGREEMENT

NOW, THEREFORE, in consideration of the benefits received, and to be received by the Owner, its successors, and assigns, as a result of the City's acceptance of the Long-Term Storm Water Management Plan the parties agree as follows:

1. Construction of Storm Water Facilities. The Owner shall, at its sole cost and expense, construct the Storm Water Facilities in strict accordance with the Development Plan, specifications, and any amendments thereto which have been accepted by the City or its agent.

2. Maintenance of Storm Water Facilities. The Owner shall, at its sole cost and expense, operate and maintain the Storm Water Facilities for flow from the property, and natural flow passing through the property, in strict accordance with the Long-Term Storm Water Management Plan. Owner's maintenance obligations shall be limited to structures, systems, and appurtenances on Owner's land, and facilities into which storm water flows outside of the public right-of-way, including all system and appurtenances built to convey storm water, as well as all structures, improvements, and vegetation provided solely to control the quantity and quality of the storm water. Maintenance, for purposes of this Agreement, is defined as good working condition so that the Storm Water Facilities are performing their design functions and capacities. The Owner shall, at its sole cost and expense, perform all work necessary to keep the Storm Water Facilities in good working condition.

3. Annual Maintenance Report. The Owner shall, at its sole cost and expense, submit an Annual Maintenance Report and Certification to the City of the Storm Water Facilities pursuant to the inspection schedule(s) in the Long-Term Storm Water Management Plan. The purpose of the Annual Maintenance Report and Certification is to assure safe and proper functioning of the Storm Water Facilities. The annual inspection shall cover all aspects of the Storm Water Facilities, including, but not limited to: parking lots, structural improvements, berms, channels, outlet structures, pond areas, access roads, vegetation, landscaping, etc. Deficiencies shall be noted in the Annual Maintenance Report. The Report shall also contain a Certification as to whether adequate maintenance has been performed and whether the structural controls are operating as designed to protect water quality. The Annual Maintenance Report and Certification shall be due by June 30, of each year and shall be in a form provided by the City with visual documentation, an example of which is attached in Exhibit "C" of the Long-Term Storm Water Management Plan, and that may be modified from time to time to accommodate laws, rules, and regulatory changes.

4. Oversight Inspection Authority. The Owner hereby grants permission to the City, its authorized agents and employees, to enter upon the Property and to inspect the Storm Water Facilities upon reasonable notice of not less than three business days to the Owner. The purpose of the inspection shall be to determine and ensure that the Storm Water Facilities are adequately maintained, are continuing to perform in an adequate manner, and are in compliance with all

applicable laws, regulations, rules, and ordinances, as well as the Long-Term Storm Water Management Plan.

5. **Notice of Deficiencies.** If the City or its agent finds the Storm Water Facilities contain any defects or are not being maintained adequately, the City or its agent shall send the Owner written notice of the defects or deficiencies and provide the Owner with reasonable time to cure such defects or deficiencies, stated in the notice. Such notice shall be sent certified mail to the Owner's address set forth below.

6. **Owner to Make Repairs.** The Owner shall, at its sole cost and expense, make such repairs, changes or modifications to the Storm Water Facilities as may be determined as reasonably necessary by the City or its agent within the required cure period to ensure the Storm Water Facilities are adequately maintained and continue to operate as designed and accepted.

7. **Corrective Action.** In the event the Owner fails to adequately maintain the Storm Water Facilities in good working condition acceptable to the City agent, the City or its agent may proceed with any enforcement mechanism provided in Heber City Code. The City or its agent may also give written notice that the Storm Water Facilities will be disconnected from the City's municipal separate storm sewer system. Any damage resulting from the disconnected system will be the Owner's responsibility. It is expressly understood and agreed that neither the City nor its agent are under any obligation to maintain or repair the Storm Water Facilities, and in no event shall this Agreement be construed to impose any such obligation on the City or its agent. The actions described in this Section are in addition to and not in lieu of the legal remedies available to the City as provided by law for Owner's failure to remedy deficiencies or any other failure to perform under the terms and conditions of this Agreement.

8. **Reimbursement of Costs.** In the event the City or its agent, pursuant to this Agreement, incurs any costs, or expends any funds resulting from enforcement or cost for labor, use of equipment, supplies, materials, and the like related to storm drain disconnection from the City's municipal separate storm sewer system, the Owner shall reimburse the City or its agent upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the City or it agent. After said thirty (30) days, such amount shall be deemed delinquent and shall be subject to interest at the rate of ten percent (10%) per annum. Owner shall also be liable for any collection costs, including attorney's fees and court costs, incurred by the City or its agent in collection of delinquent payments. The Owner hereby authorizes the City or its agent to assess any of the above-described costs, if remained unpaid, by recording a lien against the Property.

9. **Successors and Assigns.** This Agreement shall be recorded in the office of the County Recorder and the covenants and agreements contained herein shall run with the land and whenever the Property shall be held, sold, conveyed or otherwise transferred, it shall be subject to the covenants, stipulations, agreements and provisions of this Agreement which shall apply to, bind and be obligatory upon the Owner hereto, its successors and assigns, and shall bind all present and subsequent owners of the Property described herein. If the property is sold, the parties may execute an assignment of this Agreement and release of the seller's liability upon the City's consent and agreement.

10. **Severability Clause.** The provisions of this Agreement shall be severable and if any phrase, clause, sentence, or provision is declared unconstitutional, or the applicability thereof to

the Owner, its successors and assigns, is held invalid, the remainder of this Agreement shall not be affected thereby.

11. Utah Law and Venue. This Agreement shall be interpreted under the laws of the State of Utah. Suits for any claims or for any breach or dispute arising out of this Agreement shall be maintained in the appropriate court of competent jurisdiction in Salt Lake County, Utah.

12. Indemnification. This Agreement imposes no liability of any kind whatsoever on the City or its agent. The Owner hereby agrees to indemnify and hold the City and its officers, employees, agents and representatives from and against all actions, claims, lawsuits, proceedings, liability, damages, losses, and expenses (including attorneys' fees and court costs) that result from the performance of this agreement, but only to the extent the same are caused by any negligent or wrongful act or omissions of the Owner, and the Owner's officers, employees, agents, and representatives.

13. Amendments. This Agreement shall not be modified except by written instrument executed by the City and the owner of the Property at the time of modification, and no modification shall be effective until recorded in the office of the County Recorder.

14. Subordination Requirement. If there is a lien, trust deed or other property interest Recorded against the Property, the trustee, lien holder, etc., shall be required to execute a subordination agreement or other acceptable recorded document agreeing to subordinate their interest to this Agreement.

15. Exhibits and Recitals. The recitals set forth above and all exhibits to this Agreement are incorporated herein to the same extent as if such items were set forth herein in their entirety within the body of this Agreement.

[SIGNATURE PAGE TO FOLLOW]

IN WITNESS WHEREOF, the parties have signed and subscribed their names hereon and have caused this Agreement to be duly executed as of the day and year first set forth above.

OWNER

By: _____
Name: _____
Its: _____

OWNER ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF WASATCH)

On the ____ day of _____ 2022, before me _____ , personally appeared Michael Bradshaw, who being by me duly sworn, did say that he is the President of _____, a Utah corporation, and is authorized to execute the foregoing in its behalf and that he executed it in such capacity.

_____
NOTARY SIGNATURE

HEBER CITY

By: _____
Russell Funk, City Engineer

CITY ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF WASATCH)

On the ____ day of _____ 2022, before me _____ , Russell Funk who being by me duly sworn, did say that he is the City Engineer of Heber City, a political subdivision of the State of Utah, and that said instrument was signed in behalf of the City by authority of its City Council and said City Engineer acknowledged to me that the City executed the same.

_____
NOTARY SIGNATURE

EXHIBIT A
(Legal Descriptions)

Parcel ID# ??-??-???-???, LOT ... also described as:

BEGINNING...

AND

Parcel ID# ??-??-???-???, LOT ... also described as:

BEGINNING...

EXHIBIT B
(Long-Term Storm Water Management Plan)
(Separate Attachment)

EXHIBIT B

Long-Term Storm Water Management Plan

for

(Development Name)
Heber City, Utah

PURPOSE AND RESPONSIBILITY

As required by the Clean Water Act and resultant local regulations, including Heber City Storm water Management Program, those who develop land are required to build and maintain systems to minimize litter and contaminants in storm water runoff that pollute waters of the State.

This Long-Term Storm Water Management Plan (LTSWMP) describes the systems, operations and the minimum standard operating procedures (SOPs) necessary to manage pollutants originating from or generated on this property. Any activities or site operations at this property that contaminate water entering the City's storm water system or natural drainages are prohibited unless SOPs are written and accepted by the City to manage those activities or operations and amended into this LTSWMP.

The LTSWMP is aimed at protecting water quality and minimizing pollutants that could be generated by this property.

CONTENTS

SECTION 1: SITE DESCRIPTION, USE AND IMPACT

SECTION 2: TRAINING

SECTION 3: RECORDKEEPING

SECTION 4 APPENDICES

SECTION 1: SITE DESCRIPTION, USE AND IMPACT

The purpose of site infrastructure within the project is to control and contain pollutants which, if improperly managed, could adversely impact the environment. This LTSWMP includes standard operating procedures (SOP)s that are intended to direct maintenance operations and responsibly manage the grounds and infrastructure to ensure the chances of adverse impacts are minimized.

Parking, Sidewalk and Flatwork

Runoff from private roadways is the responsibility of the development. The development is also responsible for runoff from any private impervious areas or parking within the project. The various subdivisions within the project are made up of a variety of multi-family and single family lots ranging from approximately ?,000 square feet to ??,000 square feet. Each private lot has a concrete driveway. Any sediment, debris, fluids, or other waste left or that collect on these areas will be carried by runoff to the storm drain inlets. This waste material will settle in the storm drain system increasing maintenance cost and any material dissolving in the runoff will pass through the system. Maintenance involves regular sweeping, but it can also involve pavement washing to remove stains, slick spots, and oil/chemical spills when necessary. The Sweeping and the Pavement Washing SOPs are used to manage the pollutants associated with pavements.

Landscaping

This property's landscape operations can result in grass clippings, sticks, branches, dirt, mulch, fertilizers, pesticides, and other pollutants to fall or be left on paved areas. This waste material will settle in the storm drain system, increasing maintenance costs, and contributing to the solid and dissolved runoff waste that can pass through storm drain system and impact water quality. Primary pollutants of concern in the Heber area are nitrates and organic material, so it is vital that paved areas with direct connection to the City storm drain systems remain clean of landscape debris. The Landscape Maintenance SOP is written to control and manage this potential pollution source.

Storm Drain System

Storm water inlets are located within the curb and gutter of private roads and parking areas. These inlets direct all runoff from the development (developed flow) into privately maintained ponds and infrastructure. In cases where developed flow from these areas is mixed with developed flow from public roads and retained in ponds on private property, the ponds and infrastructure will be privately maintained. Maintenance will include cleaning, repair, and replacement of the facilities.

Storm water in natural drainages passing through the property (undeveloped flow) will be kept separate from storm water generated by the development. Where the natural undeveloped storm water flow is retained in ponds at roads or other crossings on private property, these ponds and infrastructure will be privately maintained. Maintenance will include cleaning, repair, and replacement of the faculties.

In cases where developed storm water flow is retained and subsequently discharged into City infrastructure downstream, the development is responsible for the quantity and quality of the storm water prior to entering the City's system.

Waste Management

Trash receptacles with lids are intended to prevent exposure to precipitation which minimizes liquids that can leak onto pavements and into the storm drain system. They also minimize the amount of light weight trash that is exposed to wind and scattered along the ground. Good waste management systems, if managed improperly, can end up as the source of the very pollution that they were intended to control. The Waste Management SOP is written to control and manage waste.

Snow and Ice Removal Management

Salt is a necessary material for ensuring safe parking and pedestrian walkways. However, snow removal operations, if improperly managed, will have an adverse impact on vegetation and local water resources.

SECTION 2: TRAINING

The purpose of training is to ensure that all homeowners and maintenance contractors know and understand the SOPs that are specifically written to manage and maintain the property. Maintenance contractors must follow good practices and meet the minimum standards described in the LTSWMP SOPs. A file of all training records in Appendix C will be maintained for review.

SECTION 3: RECORDKEEPING

Maintain records of operation and maintenance activities in accordance with SOPs. Mail a copy of the record to Heber City annually by June 30th of each year.

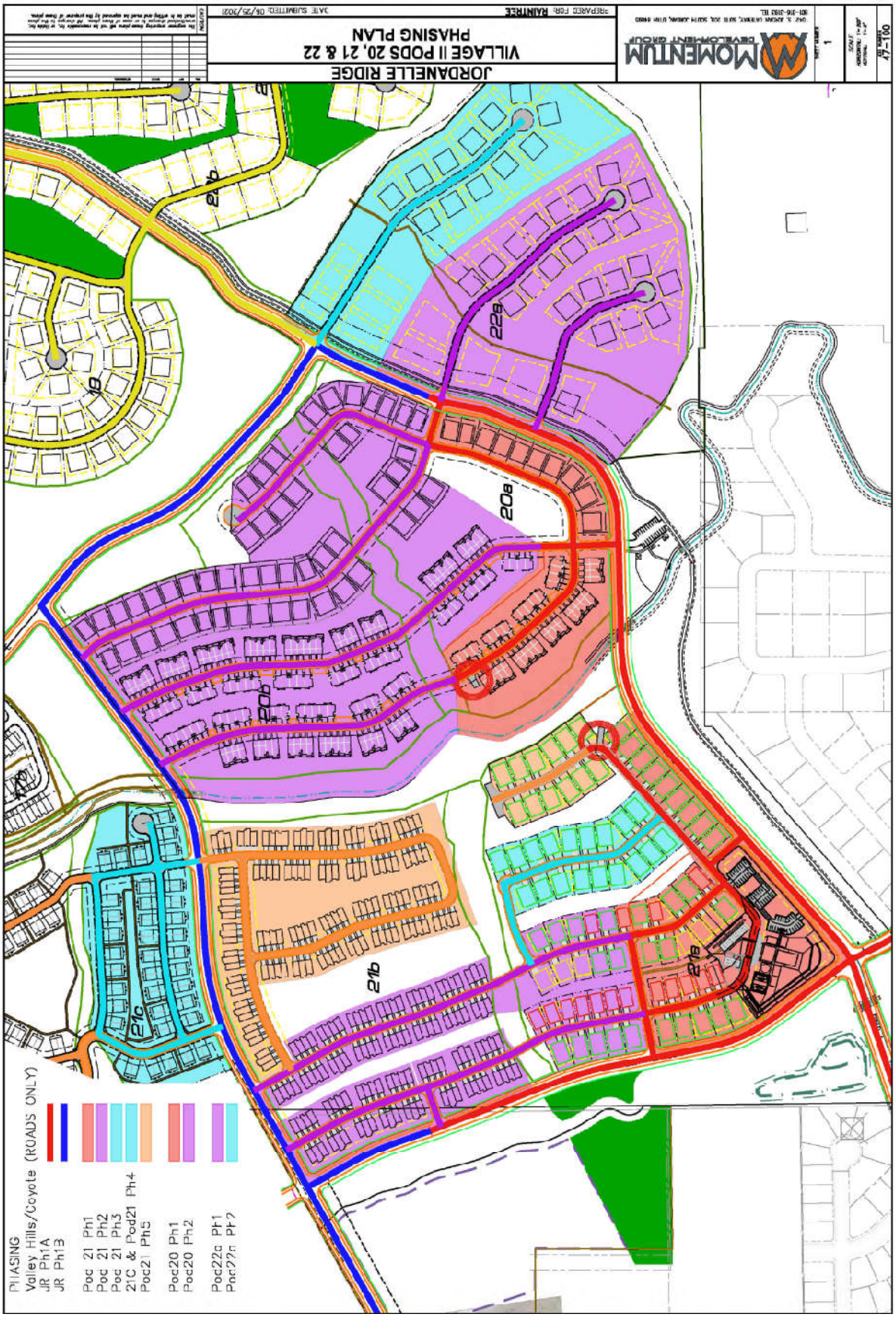
SECTION 4: APPENDICES

Appendix A- Infrastructure Locations, Site Drawings, and Details

Appendix B- SOPs

Appendix C- Recordkeeping Documents

APPENDIX A – INFRASTRUCTURE LOCATIONS, SITE DRAWINGS, AND DETAILS



APPENDIX B – SOPs

Pavement Maintenance Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Purpose and Selection:**
   a) Reduce storm water pollution by sweeping and removing pollutants that will be carried to City storm water systems during storm water runoff or by non-storm water runoff.
   b) The sweeper is intended for removing material that collects on pavements by use and the natural degradation of pavements, i.e., material that collect, drop from vehicles and the natural erosion and breaking up of pavements.

2. **Regular Procedure:**
   a) Remain aware of debris and sweep minor debris is needed by hand.
   b) Generally sweeping machinery should be used during autumn when leaf fall is heavy and early spring after winter thaw. Sometimes sweeping machinery will be necessary when accumulations are spread over a large area of the pavement.
   c) Manage outside activities that leave waste or drain pollutants to pavements. This involves outside functions including but not limited to: Yard sales, yard storage, fund raisers, etc. Do not allow car wash fund raiser or other activities that allow detergents or other pollutants to be wash into storm drain systems.

3. **Disposal Procedure:**
   a) Service contractors to dispose at licensed facilities.
   b) Dispose of hand collected materials in dumpsters.

4. **Training:**
   a) Annually and at hiring.

Landscape Maintenance Operations

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

Rule: Prevent any solids, liquids, or light weight material from being carried away from the construction or maintenance envelop by wind or water.

5. Application:

a) This SOP should provide sufficient direction for many of the general landscaping operations, e.g., fertilizer and pesticide applications, mowing, weeding, tree trimming, digging, sprinkler repairs, varying landscape cover management, etc.

6. Maintenance Procedure:

a) Grooming

- Lawn Mowing - Immediately following operation, sweep or blow clippings onto vegetated ground.
- Fertilizer Operation - Prevent overspray. Sweep or blow fertilizer onto vegetated ground immediately following operation.
- Pesticide Operation - Prevent overspray, use spot treatment, sweep, or blow dry pesticide onto vegetated ground immediately following operation.

b) Remove or contain all erodible or loose material prior forecast wind and precipitation events before any non-storm water will pass through and over the project site and at end of work period. Light weight debris and landscape materials require immediately attention when wind expected.

c) Landscape project materials and waste can usually be contained or controlled by operational best management practices.

- Operational; including but not limited to:
  - Strategic staging of materials eliminating exposure, such as not staging on pavement
  - Avoiding multiple day staging of landscaping backfill and spoil on pavements
  - Haul off spoil as generated or daily
  - Scheduling work when weather forecast are clear.

d) Cleanup:

- Use dry cleanup methods, e.g., square nose shovel and broom. It is usually sufficient when no more material can be swept onto square nosed shovel.
- Power blowing tools

7. **Waste Disposal:**
   a) Dispose of waste according to General Waste Management SOP, unless superseded by specific SOPs for the operation.

8. **Equipment:**
   a) Tools sufficient for proper containment of pollutants and cleanup.
   b) Push broom and square blade shovel should be a minimum.

9. **Training:**
   a) Annually and at hiring
   b) Landscape Service Contractors must have equal or better SOPs.

Waste Management Operations

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Application:**
   a) This SOP is for all Staff, intended for the proper disposal of common everyday waste.

2. **Waste Collection Devices (Exposed units):**
   a) The site contains the following types of waste management containers.
      - Receptacles with lids

3. **Waste Disposal Restrictions for all waste Scheduled for the Landfill:**
   a) Generally, most waste generated at this property, and waste from spill and clean up operations can be disposed in dumpsters under the conditions listed in this SOP. Unless other disposal requirements are specifically identified by the product SDS or otherwise specified in other SOPs.
   b) Know the facility disposal requirements and restrictions. It should not be assumed that all waste disposed in collection devices will be disposed of at the landfill.
   c) Review landfill regulations for additional restrictions and understand what waste is prohibited. Ensure the SDS and Landfill regulations are not contradictory. Generally, the waste prohibited by the landfill is:
      - Liquid:
        - paint
        - pesticides/fertilizers
        - oil (all types)
        - antifreeze
        - batteries
        - liquid chemicals
        - etc.

        (Generally, *all the above hazardous waste when involved in minor spill cleanup operations can be disposed in covered dumpsters and our waste bays, if the liquid is contained in absorbent material, e.g. sand, dirt, loose absorbent, pads, booms etc., and transformed or dried such that it will not drip. This is not intended for wholesale disposal of out dated or spent liquid hazardous waste. When disposal of outdated or spent liquid is*

needed or for questions of how to dispose of other waste, contact the Health Department for instructions and locations.

4. **Waste Disposal Required for Landfill or Other:**
   a) Generally, for waste not accepted by the landfill.
   b) Follow SDS for disposal requirements. Review landfill regulations for additional restrictions and understand what waste is prohibited. Ensure the SDS and Landfill regulations are not contradictory
   General rules are:
      - Get approval prior to delivery.
      - Transport waste in secure leak proof containers that are clearly labeled.
   c) Lookup and follow disposal procedures for disposal of waste at other EPA approved sites.

5. **General Staff Maintenance Practices:**
   a) Prevent dumpsters and receptacles from becoming a pollution source by:
      - Closing lids
      - Reposition tipped receptacles upright.
      - Report full or leaking and unsecured dumpsters and receptacles to the company provider or repair it in house. Determine source liquids and prevent it.
      - Report any eminent pollutant hazard related to dumpsters and receptacles to the owner.

6. **Training:**
   a) Annually and at hiring

Storm Drain Maintenance Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Procedure:**
   a) Inspect for need:
      - Schedule cleaning for boxes and pipe that contain 2" or more of sediment and debris.
      - Remove debris by vacuum operated machinery.
      - When accumulations are mostly floating debris this material can be removed with a net.
      - Inspect standing water for mosquito larvae and contact the mosquito abatement district when necessary.

2. **Disposal Procedure:**
   a) Dispose of waste collected by machinery at regulated facilities.
   b) Floating materials and floating absorbent materials may be disposed in dumpster when dried out. Dry dirt and slurry may also be disposed in the dumpster.
   c) Disposal of hazardous waste
      - Dispose of hazardous waste at regulated disposal facilities, see Waste Management and Spill Control SOP
   d) Disposal of waste collected from sanitary sewer device at regulated facilities.

3. **Training:**
   a) Annually and at hire

Pavement Washing Operations

General:

These SOPs are not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in these SOPs.

1. **Procedure:**
   a) Prevent waste fluids and any detergents if used from entering storm drain system. The following methods are acceptable for this operation.
      - Dam the inlet using a boom material that seals itself to the pavement and pick up the wastewater with shop-vacuum or absorbent materials.
      - Collect wastewater with shop-vacuum simultaneous with the washing operation.
      - Collect wastewater with vacuum truck or trailer simultaneous with the washing operation.
   b) This procedure must not used to clean the initial spills. First apply the Spill Containment and cleanup SOP.

2. **Disposal Procedure:**
   a) Small volumes can usually be drained to the local sanitary sewer. Contact the South Valley Sewer District.
   b) Large volumes must be disposed at regulated facilities.

3. **Pavement Cleaning Frequency:**
   a) There is no regular pavement washing regimen. Pavement washing is determined by conditions that warrant it, including but not limited to: prevention of slick or other hazardous conditions or restore acceptable appearance of pavements.

4. **Training:**
   a) Annually and at hiring

Snow and Ice Removal Management

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Application:**
   a) Parking and sidewalk winter management operations.

2. **De-Icing Procedure:**
   a) Do not store or allow salt or equivalent to be stored on outside paved surfaces.
   b) Minimize salt use by varying salt amounts relative to hazard potential.
   c) Sweep excessive piles left by the spreader.
   d) Watch forecast and adjust salt amounts when warm ups are expected the same day.

3. **Training:**
   a) Annually and at hiring.
   b) Require snow and ice service contractors to follow the stronger of this SOP or their company SOPs.

Spill Control

General:

This SOP is not expected to cover all necessary actions. Operators are allowed to adapt SOPs to unique site conditions in good judgment when it is necessary for safety, and the proper, and effective containment of pollutants. However, any changes of routine operations must be amended in this SOP.

1. **Rational:**
   a) All properties are susceptible to spills whether it is a result of operations or by customers. Insufficient response, inadequate containment materials and improper spill cleanup methods will result in pollutants in our waterways. Once the pollutants reach our storm drain system, or even the detention pond, they are difficult and expensive to remove.

2. **Containment Procedure:**
   a) Priority is to dam and contain flowing spills.
   b) Use spill kits booms if available or use any material available; including but not limited to, nearby sand, dirt, landscaping materials, etc.
   c) Hazardous or unknown waste material spills
      - Critical Emergency constitutes large quantities of flowing uncontained liquid that will affect areas with people or reach storm drain systems. Generally burst or tipped tanks. Call Hazmat, DWQ, Health Department, and City.
      - Minor Emergency constitutes a spill that has reached a storm drain but is no longer flowing. Call Health Department, and City
      - Spills that are contained on the surface and do not meet the criteria for Critical and minor emergencies may be managed by the responsible implementation of this SOP.

3. **Cleanup Procedure:**
   a) NEVER WASH SPILLS TO THE STORM DRAIN SYSTEMS.
   b) Clean per SDS requirements but generally most spills can be cleaned up according to the following:
      - Absorb liquid spills with spill kit absorbent material, sand or dirt until liquid is sufficiently converted to solid material.
      - Remove immediately using dry cleanup methods, e.g. broom and shovel, or vacuum operations.
      - Cleanup with water and detergents may also be necessary depending on the spilled material. However, the waste from this operation must be vacuumed or effectively picked up by dry methods. See Pavement Washing SOP.
      - Repeat process when residue material remains.

4. **DISPOSAL:**
   a) Follow SDS requirements but usually most spills can be disposed per the following b. & c.
   b) Generally, most spills absorbed into solid forms can be disposed to the dumpster and receptacles. Follow Waste Management SOP.
   c) Generally, liquid waste from surface cleansing processes may be disposed to the sanitary sewer system after the following conditions have been met:
      - Dry cleanup methods have been used to remove the bulk of the spill and disposed per the Waste Management SOP.
      - The liquid waste amounts are small and diluted with water. This is intended for spill cleanup waste only and never for the disposal of unused or spent liquids.

5. **Documentation:**
   a) Document all spills on Appendix C forms.

6. **SDS sheets:**
   a) SDS Manual is filed in break room.

7. **Materials:**
   a) Generally, sand or dirt will work for most clean up operations and for containment. However, it is the responsibility of the owner to select the absorbent materials and cleanup methods that are required by the SDS Manuals for chemicals used by the company.

8. **Training:**
   a) Annually and at hiring.

APPENDIX C – PLAN RECORDKEEPING DOCUMENTS

PURPOSE AND RESPONSIBILITY

This Maintenance Report serves to assure management and maintenance of a private storm water system as required by the Clean Water Act and resultant local regulations.

These storm water facilities are designed to manage the collection and distribution/infiltration and the quality of runoff from storm events. Annual reporting with the associated inspection provides for an ongoing awareness of their effectiveness and the general condition of the facilities and their function.

Please respond to the function and condition of the site facilities for each of the following aspects or areas of concern as a measure of its success in meeting its designed pollution protection of storm water. Include visual / photo documentation were feasible.

1. Parking, Sidewalk, impervious Area
Sediment, leaves, debris, spilt fluids or other waste that collects on parking lots and sidewalks will be carried by runoff, increasing the pollution of downstream waters.

Specific Management/Maintenance activities to address this pollution have been: _____
_____
_____
_____
_____
_____

2. Landscaping
Landscaping is often designed to capture and infiltrate storm water as a desired effect of storm water management. However, the fall of leaves along with landscape operations that produce grass clippings, sticks, dirt, mulch, fertilizers, pesticides and other pollutants that are collected in the storm water are a great impairment to that water. The primary pollutants of concern in the Heber Valley include decaying organic material and nitrates which rob water body of dissolved oxygen required to sustain fish life and impair downstream drinking water quality.

Specific Management/Maintenance activities to address this pollution have been: _____
_____
_____
_____
_____
_____

3. Storm Water Conveyance and Storage
Storm drain inlet boxes, pipe, detention ponds, etc. generally have some storm water treatment or pollution prevention as part of their design. The capture of floating trash and also the settling of heavier sediment particles to cleanout points, are a couple of examples.

Specific Management/Maintenance activities (litter retrieval, vactoring, mosquito abatement, illicit discharge detection) to support this cleanup have been: _____

4. Waste Management
Dumpsters and trash receptacles with lids are intended to prevent precipitation exposure minimizing the uptake of trash contaminants into the storm water. Lids will also prevent the lightweight trash migrating in the wind. Waste handling is necessary part of almost all sites and requires diligent attention to not become a source of storm water pollution.

Specific Management/Maintenance activities to address this pollution have been: _____

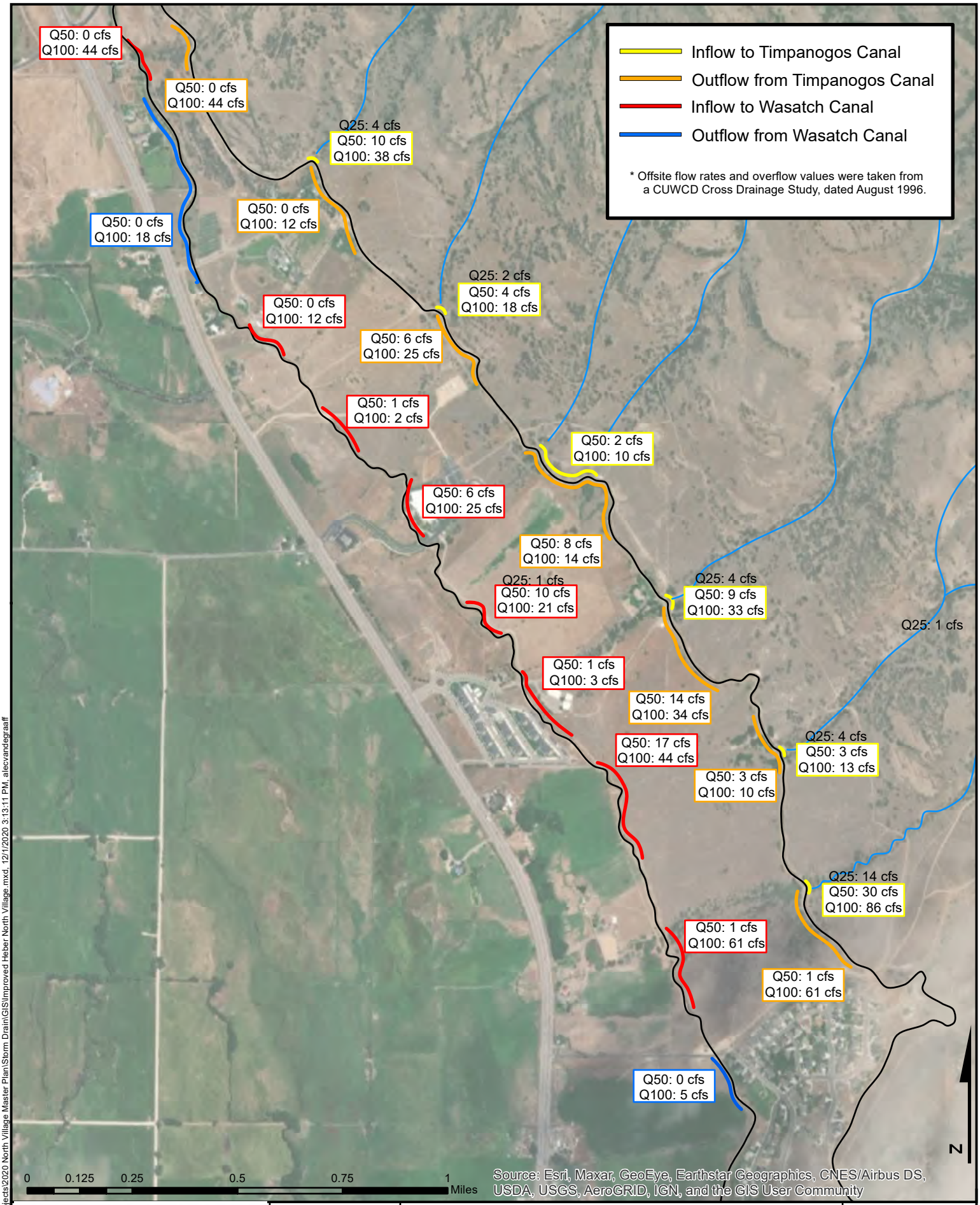
5. Construction, Mechanical/Utility Systems & Outside Equipment/Storage
Chemicals and oils are a pollution source that may be a part of mechanical and utility systems existing on site. There may also be the occasional construction or repair activity with associated equipment and materials on site which pose a pollution threat if not given proper storm water consideration.

Specific Management/Maintenance activities to address this pollution have been: _____

MAINTENANCE LOG

Date	Facility/Location, Maintenance Performed, Spill Event	Observation Notes, including but not limited to; Inspection results, Observations, System Performance (effectiveness / inefficiencies), Concerns, Necessary Changes, Etc. Include before / after photos where feasible.	Initials

Appendix 8
Cross Drainage Flow Rates Summary Map



Z:\Heber City\City Projects\2020 North Village Master Plan\Storm Drain\GIS\Improved Heber North Village.mxd, 12/1/2020 3:13:11 PM, alecvandegraaff

HORROCKS ENGINEERS

728 West 100 South
Heber, UT 84032
(435) 654-2226

Cross Drainage Flow Rates (Pre-Developed)

DATE 12/1/2020

DRAWN

Figure 1

Appendix 9
North Village Percolation Testing Summary

July 7, 2022

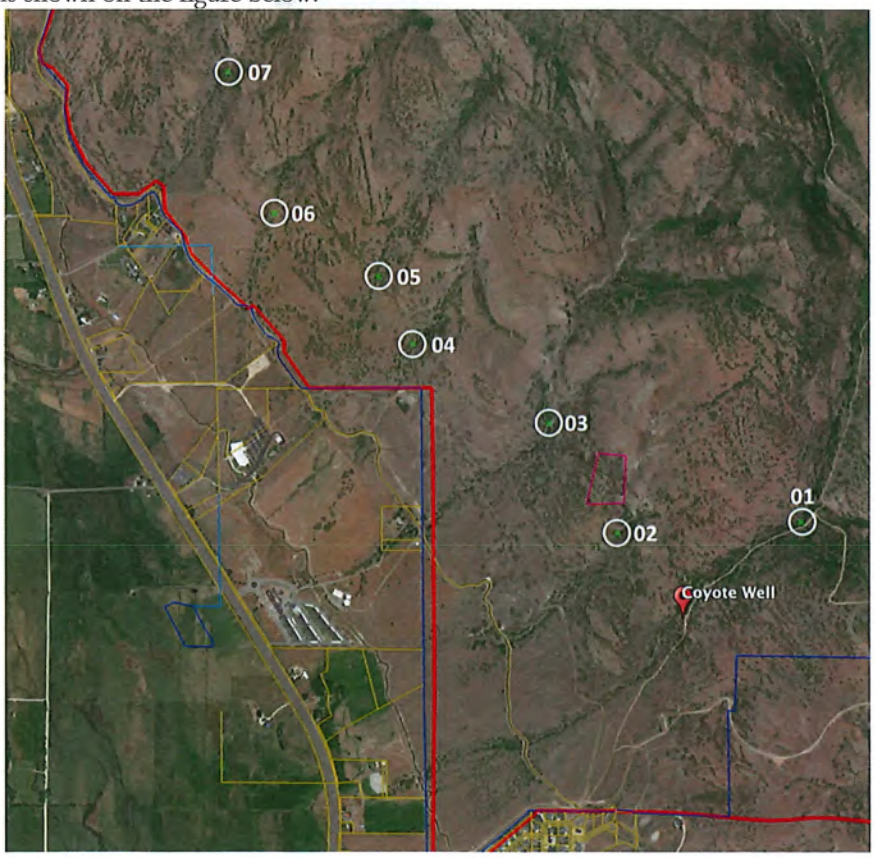
Brian Watson
Momentum Development Group, LLC
10421 South Jordan Gateway Blvd, #200
South Jordan, Utah 84095
brian@mdevg.com

RE: Storm Water Percolation Testing
Jordanelle Ridge
Heber City, UT
EPIC PROJECT #: 21SM4428

Dear Mr. Watson,

This letter summarizes Epic Engineering's storm water percolation testing for the proposed storm water detention basins to be included in the proposed Jordanelle Ridge project, Heber City, Utah. Epic Engineering's scope of work consisted only of the percolation testing on the 7 designated basin location. This letter summarizes the findings of the testing only and does not address any other engineering or geotechnical aspects of this site or surrounding areas. Soils discussed within this letter shall not supersede any soils discussed, tested, and analyzed by any geotechnical investigation.

It is Epic's understanding at the time of the soils exploration and percolation testing that the existing channels will be utilized as storm water catch basins. Percolation testing was done in the soils directly above the channel, within the basin locations shown on the figure below.



A member of Epic Engineering's geotechnical staff visited the sites on June 28-30, 2022. At the time of the site visits, the temperatures were approximately 80-90 degrees with clear skies. The native soils consisted of silty SAND and sandy SILT with gravels. A 12-inch hole was hand dug into the native soils to run percolation testing. Measurements were obtained every 30-minutes until a stabilized rate was reached. A total of 4 readings were taken at each location with final stabilized percolation rates listed in the table below.

Location	Soils	Percolation Rate (MPI)	Rate (in/hr)
Site #1	Silty SAND	5.5	10.9
Site #2	Silty SAND	15	4
Site #3	Silty SAND	8	7.5
Site #4	Sandy SILT	30	2
Site #5	Silty SAND	12	5
Site #6	Silty SAND	8	7.5
Site #7	Sandy SILT	17	3.5

Epic Engineering's scope of work consisted only of the percolation testing and soils observation of the exposed soil conditions in the test pit locations identified by the client. Other site grading activities being completed were not observed as part of this site visit. They are outside of the scope of work and are not addressed in this letter. The observations and recommendations presented in this letter were conducted within the limits prescribed by our client. No other warranty or representation, either expressed or implied, is intended in our proposals, contracts, reports, or letters.

This letter concludes the Storm Water Percolation Testing services for the proposed Storm Water basin locations as identified by the client above for the Jordanelle Ridge project, Heber City, Utah. Please contact Epic Engineering at (435) 654-6600 if you would like to discuss the results of this storm water percolation test or have other questions.

Sincerely,
Epic Engineering, P.C.



Torrey Copfer, P.G.
Engineering Geologist

Appendix 10
North Village Drainage Area

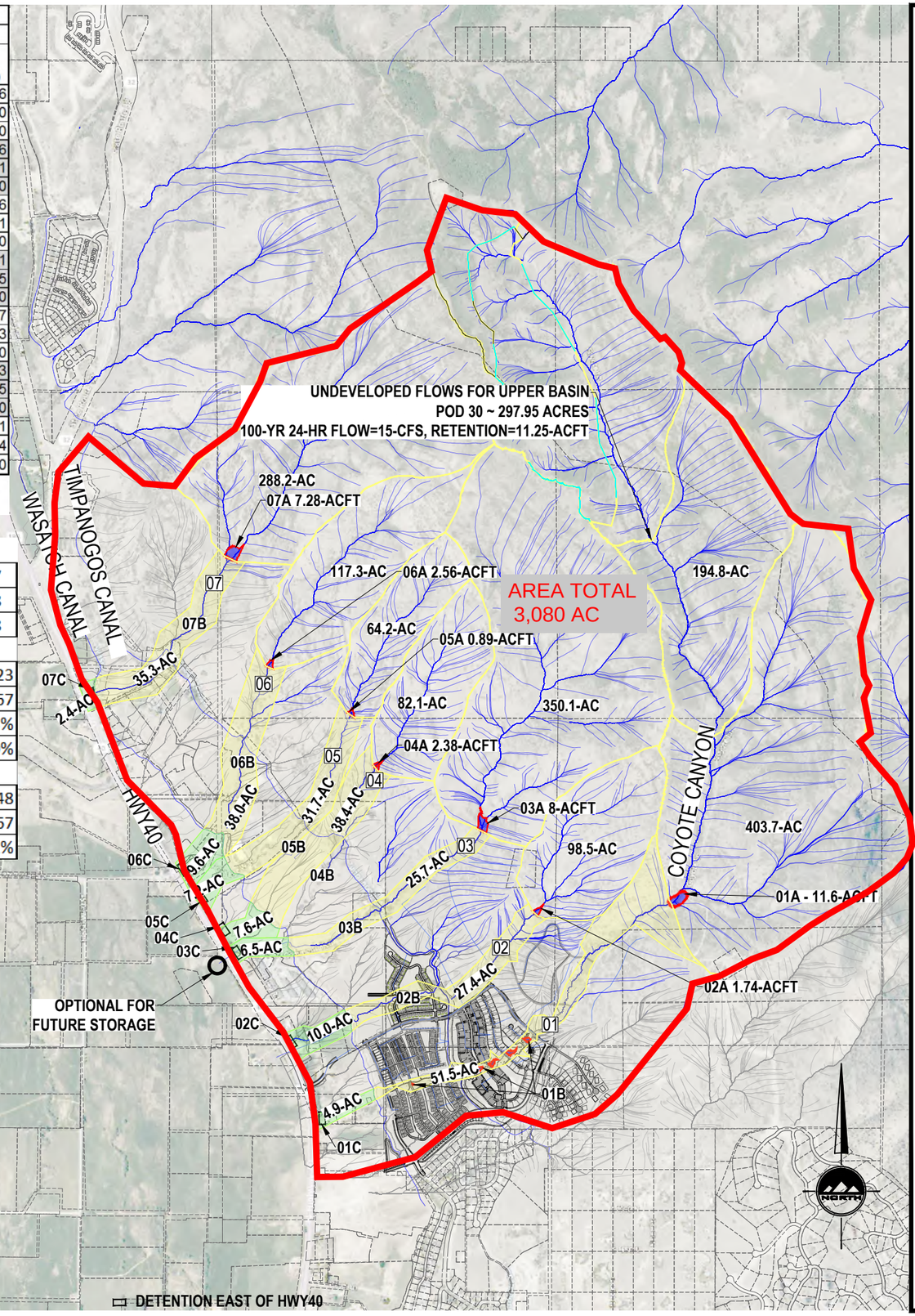
UNDEVELOPED FLOWS THROUGH JORDANELLE CANYONS WITH DRAINAGE IMPROVEMENTS

STORAGE / LID MEASURE		HISTORIC 100-YR 24-HR PEAK IN (CFS)	HISTORIC 100-YR 24-HR STOR (ACFT)	INFIL. (IN/HR)	100-YEAR PEAK IN (CFS)	100-YEAR STOR (ACFT)	100-YEAR INFIL (ACFT)	25-YEAR PEAK IN (CFS)	25-YEAR STOR (ACFT)	25-YEAR INFIL (ACFT)	10-YEAR PEAK IN (CFS)	10-YEAR STOR (ACFT)	10-YEAR INFIL (ACFT)
01A	SEDIMENT BASIN	162	87	5.45	65.9	11.60	9.05	30.5	9.39	39.19	17.7	5.98	27.96
01B	ROADS / TRAILS			27	22.6	1.15	16.79	0.8	0.00	0.00	0.4	0.00	0.00
01C	EAST HWY 40 *			2	0.8	* 0.50	0.01	0.1	0.00	0.00	0.1	0.00	0.00
02A	SEDIMENT BASIN	33	13	2	25.3	1.74	0.80	10.2	1.74	4.76	5.4	1.48	3.66
02B	ROADS / TRAILS			2	11.9	2.06	2.19	1.4	0.00	0.98	0.2	0.00	0.11
02C	EAST HWY 40 *			2	1.2	* 0.50	0.02	0.2	0.00	0.00	0.1	0.00	0.00
03A	SEDIMENT BASIN	100	35	3.75	54.1	8.00	4.80	23.1	8.00	17.95	12.5	5.35	12.06
03B	ROADS / TRAILS			2	17.7	2.33	1.49	0.5	0.00	0.37	0.2	0.00	0.11
03C	EAST HWY 40 *			2	11.1	1.56	1.03	0.2	0.00	0.00	0.1	0.00	0.00
04A	SEDIMENT BASIN	42	12.5	1	23.1	2.38	0.36	9.6	1.59	3.69	4.8	1.16	3.21
04B	ROADS / TRAILS			1	2.7	0.42	1.01	0.7	0.00	0.46	0.3	0.00	0.15
04C	EAST HWY 40 *			1	1.0	* 0.50	0.01	0.2	0.00	0.00	0.1	0.00	0.00
05A	SEDIMENT BASIN	16	7	2.5	12.5	0.89	0.55	4.4	0.46	3.14	2.4	0.28	2.17
05B	ROADS / TRAILS			2	2.5	0.15	1.64	0.6	0.00	0.38	0.2	0.00	0.13
05C	EAST HWY 40 *			2	1.0	* 0.50	0.01	0.2	0.00	0.00	0.1	0.00	0.00
06A	SEDIMENT BASIN	41	14.5	3.75	80.5	2.56	1.32	32.9	1.61	6.72	14.5	1.14	4.63
06B	ROADS / TRAILS			2	2.7	0.18	1.83	0.7	0.00	0.45	0.3	0.00	0.15
06C	EAST HWY 40 *			2	1.2	* 0.50	0.04	0.2	0.01	0.01	0.1	0.00	0.00
07A	SEDIMENT BASIN	90	34	1.75	40.1	7.28	1.91	16.6	4.28	13.32	8.8	2.77	9.11
07B	ROADS / TRAILS			2	2.6	0.20	1.62	0.6	0.00	0.42	0.3	0.00	0.14
07C	EAST HWY 40 *			2	0.7	* 0.50	0.01	0.1	0.00	0.00	0.0	0.00	0.00

* Minimum basin size at bottom of all drainages (0XC) is 0.5-acft. Volumes and inflow listed are based on assumed undeveloped area and will need to be verified with individual overall drainage basin/development plans.

DEBRIS BASIN VOLUME SUMMARY

		01	02	03	04	05	06	07
Stormwater Volume Planned		13.60	3.80	11.89	2.80	1.04	2.74	7.48
With 0.5 acft minimum at Hwy 40		14.10	4.30	11.89	3.30	1.54	3.24	7.98
Cannon et al. equation (2010)	***Volume (ac-ft)***	14.10	2.33	8.68	2.09	1.54	3.00	7.23
10-year 60-minute depth (in)		0.867	0.867	0.867	0.867	0.867	0.867	0.867
% of Area over 30% Slopes		74%	54%	71%	58%	49%	65%	73%
	Percent Burn	80.7%	100.0%	100.0%	100.0%	94.17%	100.0%	100.0%
Gartner et al equation (2014)	***Volume (ac-ft)***	13.03	4.09	11.59	3.29	1.54	3.24	7.48
5-year 60-minute intensity (in/hr)		1.67	1.67	1.67	1.67	1.67	1.67	1.67
	Percent Burn	100.00%	100.00%	100.00%	73.40%	12.13%	13.65%	29.02%



HORIZONTAL GRAPHIC SCALE

2,000'-0"

-2000 0 1000 2000 4000

(IN FEET)

HORZ: 1 inch = 2000ft.

ENSIGN
THE STANDARD IN ENGINEERING

SALT LAKE CITY
45 W. 10000 S., Suite 500
Sandy, UT 84070
Phone: 801.255.0529

LAYTON
Phone: 801.547.1100

TOOELE
Phone: 435.843.3590

CEDAR CITY
Phone: 435.865.1453

RICHFIELD
Phone: 435.896.2983

WWW.ENSIGNENG.COM

FOR:
MOMENTUM DEVELOPMENT GROUP, LLC
10421 SOUTH JORDAN GATEWAY BLVD, #200
SOUTH JORDAN, UTAH 84095
CONTACT:
DAVE BARBEE
PHONE: 801-316-3193

NORTH VILLIAGE
UNDEVELOPED DRAINAGE MASTER PLAN
700 COYOTE LANE
HEBER CITY, UTAH

UNDEVELOPED DRAINAGE
COYOTE CANYON
DISCHARGE VOLUMES
UPDATED INFIL RATES

PROJECT NUMBER 10229A
PRINT DATE 7/19/22
DRAWN BY C. DUNKEL
CHECKED BY B. MORGAN
PROJECT MANAGER B. MORGAN

EX-110

Appendix 11
Storm Water Facility Cost Summary

North Village Storm Drain Price List

	Size	Description	Price	Units
j	18	Pipe	$80.00	LF
j	24	Pipe	$100.00	LF
j	36	Pipe	$140.00	LF
j	48	Pipe	$180.00	LF
k	18	Casing	$207.00	LF
k	24	Casing	$235.00	LF
k	36	Casing	$300.00	LF
k	48	Casing	$600.00	LF
k		Canal Concrete Lining	$150,000.00	LF
l		Upper Detention Basin	$200,000	AF
m		Intermediate Detention Basin	$240,000	AF
n		US40 Retention Basin	$150,000	AF
j		Site Restoration	$0.75	SF
m		Irrigation and Landscaping	$3.00	SF
o		Land	$200,000	AC
r		Design, CM, Insp	18%	
r		Contingency	30%	

NOTES / ASSUMPTIONS:

- Pipe and Casing costs from Heber Data Base and JRidge 2 development.
- Upper Detention Basin Costs Include: Excavation, High Embankment Fill, Emerg overflow, Pipes, Inlet/Outlet Structures, Site restoration (% of basin area), etc
  Avg cost per AF = $200 AF per JRidge2. Disturbed area scaled from topo.
- Intermediate Detention Basin Costs Include: Excavation, Low Embankment Fill, Emerg overflow, Pipes, Inlet/Outlet Structures, Site restoration (% of basin area), LID's, etc
  Avg cost per AF = $240 AF per JRidge2 and Area / Vol ratio 0.81 AC/AF.
- US40 Retention Basin Costs Include: Excavation, Low Embankment Fill (Assume 5' depth), Inlet Structure, Sumps, Landscaping, etc.
  Avg cost per AF = $150 AF per assumed and Area / Vol ratio 0.68 AC/AF per JRidgex2.
- Canal Crossing Costs Include: Pipe, Casing (50% of pipe length), Inlet/Outlet, Boring/Ex, Concrete channel lining (100 ft), etc.
- Design Costs Include: Cost Mgmt, Inspection, Dam Safety Coord, etc.
- Land assumed value.

Cost Summary of Recommended Storm Drain Improvements

NORTH VILLAGE STORM DRAIN CAPITAL IMPROVEMENTS

		IMPROVEMENT DESCRIPTION	LENGTH, QUANTITY, COST	VOLUME	PEAK FLOW	DISTURBED AREA		LUMP SUM	PIPE SIZE	CASING SIZE	Upper Basin	Mid Basin	US40 Basin	SITE RESTORE	IRR & LANDSCAP	LAND	ENG CM INSP	TOTAL PROJECT COST
ULT				AF	CFS	AC		i	j	k	l	m	n	o	p	q	r	
	D-01A	Upper Detention Basin - Coyote	1	11.60	65.9	4.78					X			100%			X	$3,798,433
	D-01B	Intermediate Detention Basins - Coyote		1.15	22.6	0.93						X		100%		X	X	$755,851
	D-01C	US40 Retention Basin - Coyote	1	0.50	0.8	0.34							X		100%	X	X	$287,519
	D-01D	Timp Canal Crossing - Coyote	100						36	48							X	$297,596
	D-01E	Wasatch Canal Crossing - Coyote	100						36	48							X	$297,596
	D-02A	Upper Detention Basin - Fitzgerald	1	1.74	25.3	0.86					X			100%			X	$576,932
	D-02B	Intermediate Detention Basins - Fitzgerald		2.06	11.9	1.67						X		100%		X	X	$1,353,959
	D-02C	US40 Retention Basin - Fitzgerald	1	0.50	1.2	0.34							X		100%	X	X	$287,519
	D-02D	Timp Canal Crossing - Fitzgerald	100						36	48								$252,200
	D-02E	Wasatch Canal Crossing - Fitzgerald	100						36	48								$252,200
	D-03A	Upper Detention Basin - Commons	1	8.00	54.1	2.92					X			100%			X	$2,600,738
	D-03B	Intermediate Detention Basins - Commons		2.33	17.7	1.89						X		100%		X	X	$1,531,420
	D-03C	US40 Retention Basin - Commons	1	1.56	11.1	1.06							X		100%	X	X	$897,061
	D-03D	Timp Canal Crossing - Commons	100						36	48							X	$297,596
	D-03E	Wasatch Canal Crossing - Commons	100						36	48							X	$297,596
	D-04A	Upper Detention Basin - Highlands	1	2.38	23.1	1.02					X			100%			X	$781,302
	D-04B	Intermediate Detention Basins - Highlands		0.42	2.7	0.34						X		100%		X	X	$276,050
	D-04C	US40 Retention Basin - Highlands	1	0.50	1.0	0.34							X		100%	X	X	$287,519
	D-04D	Timp Canal Crossing - Highlands	100						36	48							X	$297,596
	D-04E	Wasatch Canal Crossing - Highlands	100						36	48								$252,200
	D-05A	Upper Detention Basin - UVU	1	0.89	12.5	0.78					X			100%			X	$312,142
	D-05B	Intermediate Detention Basins - UVU		0.15	2.5	0.12						X		100%		X	X	$98,589
	D-05C	US40 Retention Basin - UVU		0.50	1.0	0.34							X		100%	X	X	$287,519
	D-05D	Timp Canal Crossing - UVU	100						36	48								$252,200
	D-05E	Wasatch Canal Crossing - UVU	100						36	48								$252,200
	D-06A	Upper Detention Basin - Views	1	2.56	80.5	1.06					X			100%			X	$838,531
	D-06B	Intermediate Detention Basins - Views		0.18	2.7	0.15						X		100%		X	X	$118,307
	D-06C	US40 Retention Basin - Views	1	0.50	1.2	0.34							X		100%	X	X	$287,519
	D-06D	Timp Canal Crossing - Views	100						36	48							X	$297,596
	D-06E	Wasatch Canal Crossing - Views	100						36	48							X	$297,596
	D-07A	Upper Detention Basin - Crossings	1	7.28	40.1	2.01					X			100%			X	$2,334,237
	D-07B	Intermediate Detention Basins - Crossings		0.20	2.6	0.16						X		100%		X	X	$131,452
	D-07C	US40 Retention Basin - Crossings	1	0.50	0.7	0.34							X		100%	X	X	$287,519
	D-07D	Timp Canal Crossing - Crossings	180						36	48							X	$351,593
	D-07E	Wasatch Canal Crossing - Crossings	100						36	48								$252,200
	D-08A	Master Plan Updates every 5 years (4 times)	$120,000					X										$156,000
		TOTAL STORM DRAIN:		45.50														**$22,234,086**

Planning Commission Staff Report

MEETING DATE:	September 13, 2022
SUBJECT:	Public Hearing for Amendments to the Telecommunication Ordinance
RESPONSIBLE:	Anthony L. Kohler, Planning Director
DEPARTMENT:	Planning Department
STRATEGIC RELEVANCE:	Community Development

SUMMARY

As part of the Phase 3 Envision Heber Code Update ordinances are being amended.

Policy questions and/or new content are identified in the drafts. Most amendments are purely updates to comply with State Code.

RECOMMENDATION

Staff recommends the Planning Commission hold the public hearing and consider making a recommendation to the City Council after the public hearing.

BACKGROUND

Envision Heber Phase 3 involves ordinance updates and amendments. These ordinance amendments are a result of the contract with People + Place, John Janson, Meg Ryan and the Planning Department staff. The proposals within the drafts include policy suggestions, State Law updates, and edits for greater clarity.

Here is a summary of the changes for discussion:

Telecommunications Chapter 18.110

The proposed draft:

1. Updates approval terms and specifies approving authority

2. Deletes outdated law and approval processes.
3. Moves review standards to correct code sections (for example conditional uses and non-conforming uses)
4. One question for Planning Commission review is within section 18.110.1650 Site Requirements Use of Property. The telecommunications facility shall be an ancillary use on the lot on which it is placed. The lot shall contain a separate principal use.
   Does a tower need to be associated with another use?
5. No new major policy changes are made in the proposed draft.

DISCUSSION

The proposed amendments update the Telecommunications Ordinance Chapter 18.110.

FISCAL IMPACT

No additional costs other than the consultant contract are involved.

CONCLUSION

A recommendation from the Planning Commission may be made after the public hearing or at a subsequent meeting. The content changes are not considered controversial.

ACCOUNTABILITY

Department: Planning Department, Planning Director
Staff Member: Anthony L. Kohler

EXHIBIT -Draft Ordinance

Telecommunications Chapter 18.110

18.110 Telecommunication Facilities

18.110.010 Purpose
18.110.020 Findings
18.110.030 Definitions
18.110.040 Applicability
18.110.050 Application Requirements
18.110.060 Approval Process
18.110.070 Location
18.110.080 Uses
18.110.090 Co-Location

18.110.100 Lease Agreement
18.110.110 Development Standards
~~18.110.120 Additional Conditional Use Permit Considerations~~
18.110.1320 Additional Regulations For Monopoles And Towers
18.110.1430 Area Limitations For Wall And Roof Mounted Antennas
18.110.1540 Safety
18.110.1650 Site Requirements
18.110.1760 Site Disturbance
18.110.18 70 Signs
18.110.1980 Subdivision And Condominium Covenants
~~18.110.200 Expansion, Alteration, And Nonconforming Uses~~
~~18.110.210 Telecommunication Facilities To Permit, As A Conditional Use, A Radio Antenna~~

18.110.010 Purpose

The purposes of this ordinance are:

A. To regulate wireless services antennas and related electronic equipment and structures.
B. To provide for the orderly establishment of wireless services facilities in the City.
C. To minimize the number of antenna support structures by encouraging the use of stealth facilities, by encouraging the co-location of multiple antennas on a single structure, by encouraging the location of antennas on pre-existing support structures, and by encouraging the use of City and Government-owned property for antenna support structures.
D. To establish siting, appearance, and safety standards that will help mitigate potential impacts related to the construction, use and maintenance of wireless services facilities.
E. To comply with the Telecommunications Act of 1996 by establishing regulations that (1) do not prohibit or have the effect of prohibiting the provision of wireless services, (2) do not unreasonably discriminate among providers of functionally equivalent services, and (3) are not based on the environmental effects of radio frequency emissions to the extent that such facilities comply with the Federal Communication Commission's regulations concerning such emissions.

18.110.020 Findings

The City Council makes the following findings:

A. Wireless services devices are an integral part of the rapidly growing and evolving telecommunications industry and present unique zoning challenges and concerns for the City.
B. The City needs to balance the interests and desires of the telecommunications industry and its customers to provide competitive and effective telecommunications systems in the City, against the sometimes differing interests and desires of others concerning health, safety, welfare, aesthetics, and orderly planning of the community.
C. The City has experienced an increased demand for wireless services facilities to be located in the City and expects the increased demand to continue into the future.

D. It is in the best interests of the City to have quality wireless services available, which necessarily entails the erection of wireless services facilities in the City.
E. The unnecessary proliferation of wireless services facilities throughout the City creates a negative visual impact on the community.
F. The visual effects of wireless services facilities can be mitigated by fair standards regulating their sitting, construction, maintenance and use.
G. The City and other government entities own parcels of property spread throughout the City where wireless services facilities can be located so as to be as inoffensive as possible to the residents and businesses of the City.
H. Spacing wireless services facilities evenly throughout the city reduces the negative impact created by the proliferation of telecommunication towers.
I. Because of the height and appearance of some wireless services facilities, surrounding properties bear a disproportionate share of the negative impacts of a telecommunications tower.
J. A private property owner who leases space for a wireless services facility is the only one who receives compensation for the facility, even though numerous other property owners in the area are adversely affected by the location of the facility.
K. Encouraging wireless services facilities to be located on City and Government property, with lease payments paid to the City or other Governments instead of an individual property owner, indirectly compensates all citizens of the community for the adverse impacts of the facilities and is therefore the fairest method of distributing burden and benefit.
L. Locating antennas on existing buildings and structures, or constructing an antenna as a stealth facility, creates less of a negative visual impact on the community than the erection of towers.
M. Buildings and structures on public property are capable of being used to provide support for antenna arrays, thus reducing the proliferation of towers in all areas of the City.
N. The public policy objectives to reduce the proliferation of telecommunication towers and to mitigate their impact can best be facilitated by encouraging the use of less visually intrusive antennas and permitting the locating of wireless communication systems on telecommunication towers and antenna support structures that are located on property owned, leased, or used by the City or other Governments.
O. The requirements set forth in this ordinance for the placement of wireless services facilities on property owned, leased or used by the City or other Governments are necessary to protect the health, safety and general welfare of the community.
P. The Utah Code grants cities the authority to create or acquire sites to accommodate the erection of telecommunication towers in order to promote the location of telecommunication towers in a manageable area and to protect the aesthetics and environment of the area. The law also allows the City to require the owner of any tower to accommodate the multiple use of the tower by other companies where feasible and to pay the City or other Governments the fair market rental value for the use of any City or other Government-owned site.

18.110.030 Definitions

1. ANTENNA. A device that transmits and/or receives telecommunications and/or radio signals for telecommunications and communication equipment that transmits or receives an electromagnetic radio frequency signal used in the provision of wireless service.
2. ANTENNA SUPPORT STRUCTURES. Any structure that can be used for the purpose of supporting an antenna(s).
3. ANTENNA, DRIVE TEST. A temporary antenna which is used for field testing of telecommunications signals and possible locations but does not provide telecommunications to customers.
4. ANTENNA, ENCLOSED. An antenna or series of individual antennas entirely enclosed inside a structure including but not limited to a cupola or wall of a building or chimney.
5. ANTENNA, FREESTANDING. An antenna mounted on or within a stand-alone support structure including but not limited to a wooden pole, steel pole, lattice tower, utility pole, lift tower, light standard, flag pole or other vertical support.
6. ANTENNA, ROOF MOUNTED. An antenna or series of individual antennas mounted on a roof of a building.
7. ANTENNA, TEMPORARY. An antenna used for a time period of less than thirty (30) days.
8. ANTENNA, WALL MOUNTED. An antenna or series of individual antennas mounted fully against the exterior face of a building including on the face of a chimney or penthouse. A wall or face of a building is defined as the entire area of all exposed vertical surfaces of a building that are above ground and facing approximately the same direction.
9. APPLICABLE CODES: The International Building Code, the International Fire Code, the National Electrical Code, the International Plumbing Code, and the International Mechanical Code, as adopted and amended under Utah Code Annotated, title 15A, State Construction and Fire Codes Act.
10. APPLICABLE STANDARDS: The structural standards for antenna supporting structures and antenna, known as ANSI/TIA-222, from the American National Standards Institute and the Telecommunications Industry Association.
11. APPLICANT: A wireless provider or their authorized agent who submits an application.
12. APPLICATION: A request submitted by a wireless provider for a permit to co-locate a small wireless facility in a right-of-way or to install, modify or replace a utility pole or a wireless support structure.
13. CITY. The City of Heber, Utah.
14. CITY-OWNED PROPERTY. Real property that is owned, leased or controlled by the City.
15. CO-LOCATION. The location of telecommunication facility on an existing structure, tower or building in a manner that precludes the need for that telecommunications facility to be located on a free-standing structure of its own.
16. DIRECTOR. The Planning Director or designee.
17. ELIGIBLE SUPPORT STRUCTURE: Any monopole, utility pole, wireless support structure or related accessory equipment, as defined in this chapter, provided that it is existing at the time the relevant application is filed with the City.
18. EQUIPMENT SHELTER. A cabinet or building used to house equipment for telecommunications facilities.
19. GOVERNMENT-OWNED PROPERTY. Real property that is owned, leased or controlled by an agency of State, Federal, or Local government other than Heber City.

20. LATTICE TOWER. A self-supporting three or four-sided, open steel frame structure used to support telecommunications equipment.
21. MONOPOLE. A structure in the right-of-way erected by an applicant or provider specifically to support SWFs and a single, self-supporting, cylindrical pole constructed without guy wires or ground anchors, that acts as the support structure for antennas.
22. MONOPOLE ANTENNA WITH PLATFORM. A monopole with antennas and antenna support structure exceeding two feet (2') in width, but not exceeding fifteen feet (15') in width or eight feet (8') in height.
23. MONOPOLE ANTENNA WITH NO PLATFORM. A monopole with antennas and antenna support structure not exceeding two feet (2') in width or ten feet (10') in height.
24. PERMIT. Written authorization from the City allowing the provider to perform work pursuant to the installation of a small wireless facility.
25. PERMITTED. An application that is permitted pursuant through the standard building permit process.
26. Personal Wireless Services. Commercial mobile telecommunications services, unlicensed wireless telecommunications services, and common carrier wireless telecommunications exchange access services.
27. Personal Wireless Services Antenna. An antenna used in connection with the provision of personal wireless services.
28. Personal Wireless Services Facilities. Facilities for the provision of personal wireless services. Personal wireless services facilities include transmitters, antennas, structures, supporting antennas, and electronic equipment that is typically installed in close proximity to a transmitter.
29. RIGHT-OF-WAY. Refers to any area within, on, below, or above a public road, highway, street or alley, and may include sidewalks, park-strips and other areas associated with them and controlled by the City.
30. STEALTH TELECOMMUNICATIONS FACILITY. A telecommunications facility which is disguised as another object or otherwise concealed from public view.
31. TELECOMMUNICATIONS. The transmission between or among points specified by a user of information of the user's choosing without change in the form or content of the information as sent or received.
32. TELECOMMUNICATIONS FACILITY. A Telecommunications Facility consists of antenna, equipment shelters and related structures used for transmitting and/or receiving telecommunications and/or radio signals.
33. TOWER. A free-standing structure, such as a monopole tower, lattice tower, or guy tower, that is used as a support structure for antenna(s).
34. WHIP ANTENNA. An antenna that is cylindrical in shape. Whip antennas can he directional or omni directional and vary in size depending on the frequency and gain for which they are designed.
35. TECHNICAL NECESSITY. A particular design, placement, construction, or location of a telecommunications facility that is technically necessary for telecommunications consistent with the Federal Telecommunications Act of 1996, as amended.

18.110.040 Applicability

This ordinance applies to both commercial and private low power radio services and facilities, such as "cellular" or PCS (personal communications system) communications and paging systems, and to wireless Internet service providers. This ordinance shall not apply to the following types of communications devices, although they may be regulated by other City ordinances and policies:

A. Amateur Radio. Any antenna owned and operated by an amateur radio operator licensed by the Federal Communications Commission.
B. Satellite/television antenna. Any device designed for over-the-air reception of television broadcast signals, multichannel multipoint distribution service or direct satellite service.
C. Cable. Any cable television head-end or hub towers and antennas used solely for cable television services.

18.110.050 Application Requirements

Any person desiring to develop, construct or establish a personal wireless services facility in the City shall submit an application for site plan approval to the City. The City shall not consider the application until all required information has been included. A complete application shall include all elements of the proposed telecommunications facility and shall produce all information required by the telecommunications facility application. Applicants shall provide the following submittal requirements.

A. Fee. ~~A fee of $100.00~~ As adopted by the Heber City Consolidated Fee Schedule.
B. Site Plan. A site plan meeting the City's standard requirements for site plans.
C. Written Information.
    1. Environment. A full description of the environment surrounding the proposed facility, including a description of adjacent uses, any adjacent residential structures, and any structures and sites of historic significance.
    2. Maintenance. A description of the anticipated maintenance needs for the facility, including frequency of service, personnel needs, equipment needs, and traffic noise or safety impacts of such maintenance.
    3. Service Area. A description of the service area for the antenna or tower and a statement as to whether the antenna or tower is needed for coverage or capacity.
    4. Location. A map showing the site and the nearest or associated telecommunications facility sites within the network. Describe the distance between the telecommunications facility sites. Describe how this service area fits into the service network.
        a. An Applicant proposing to erect a new telecommunications facility shall provide documentary evidence that a legitimate attempt has been made to locate the new telecommunications facility on City or Government owned properties, existing buildings or structures or co-location. Such evidence shall include a radio frequency engineering analysis of the potential suitability of existing buildings or structures or co-location sites in the radio frequency coverage area for the proposed telecommunications facility. Efforts to secure such locations shall be documented through

correspondence between the applicant and the property owner(s) of the existing buildings, structures or co-location sites.

b. Applicants proposing to construct new telecommunications facilities shall document the locations of all of the applicant's existing telecommunications facilities that provide telecommunications within the City, as well as any changes proposed within the following twelve (12) month period, including plans to discontinue or replace such existing telecommunications facilities. Applicants shall provide competent testimony from a radio qualified professional regarding the suitability of potential telecommunications facility locations in relation to the applicant's existing telecommunications facilities.

c. Each application shall include a site location alternative analysis describing the location of other sites considered for the proposed telecommunications facility, the availability of those sites, the extent to which other sites do or do not meet the applicant's telecommunications needs and the reason the subject site was chosen for the proposed telecommunications facility. The analysis shall address the following issues:

    1) How the proposed location and telecommunications facility relate to the object of providing full telecommunications services within the City area;
    2) How the proposed telecommunications facilities relates to the location of the applicant's existing telecommunications facilities that provide telecommunications within and near the City;
    3) How the proposed telecommunications facility relates to the applicant's anticipated need for additional telecommunications facilities that provide telecommunications within and near the City;
    4) If applicable, how the applicant's plans specifically relate to, and are coordinated with, the needs of all other telecommunications providers within and near the City.

5. Licenses and Permits. Copies of all licenses and permits required by other agencies and governments with jurisdiction over the design, construction, location and operation of the antenna.
6. Radio Frequency Emissions. A written commitment to comply with applicable Federal Communications Commission radio frequency emission regulations.
7. Visibility Impact. A visual impact study, graphically simulating through models, computer enhanced graphics or similar techniques, the appearance of any proposed telecommunications facility and indicating its view from at least five (5) locations around and within one (1) mile of the proposed telecommunications facility will be most visible.
8. Liaison. The name of a contact person who can respond to questions concerning the application and the proposed facility. Include name, address, telephone number, facsimile number and electronic mail address, if applicable.
9. Additional information requirements for monopoles. If the applicant desires to construct a monopole, the applicant shall also submit a detailed written

description of why the applicant cannot obtain coverage using existing buildings or structures.

10. Additional information requirement for facilities not located on highest priority site. If the applicant desires to locate antennas on a site other than the highest priority site (as described in Section 18.110.070), the applicant shall provide the following information to the approving authority:
    a. Higher priority sites. The identity and location of any higher priority sites located within the desired service area.
    b. Reason for rejection of higher priority sites. The reason(s) why the higher priority sites are not technologically, legally or economically feasible.
    c. Justification for proposed site. Why the proposed site is essential to meet the service demands of the geographic service area and the citywide network.

18.110.060 Approval Process

All telecommunication facilities shall be reviewed by the ~~City~~ Planning Director or designee, pursuant to its standard site plan and building permit approval process. ~~If the facility requires a conditional use permit, the review shall be pursuant to the City's standard Commercial Concept approval process in Section 17.38 of Heber City Code.~~ Permitted uses are reviewed and approved but the Planning Director or Designee, Conditional Use Permits are approved by the Planning Commission as regulated in Chapter 18.70.It shall be unlawful to install any telecommunication facility without first having a permit from the Planning and Building Departments of the City. ~~No building permit shall be issued for any project for which a site plan, amended site plan or conditional use permit is required, until the site plan, amended site plan or conditional use permit has been approved by the appropriate authority. In the event the Planning Department believes that a permitted application does not conform to applicable standards, the Department may refer the application to the Planning Commission for approval and interpretation through the Commercial Concept approval process in Section 17.38 of Heber City Code.~~

18.110.070 Location

A. Priority of antenna site locations. Personal wireless services antennas shall be located as unobtrusively as is reasonably possible. To accomplish this goal, the provider shall make a good faith effort to locate antennas on sites in the following order of priority:
    1. Structures located on City-owned property. Existing buildings, structures and antenna support structures located on City-owned property.
    2. Structures located on Government-owned property. Existing buildings, structures and antenna support structures located on Government-owned property.
    3. Monopoles located on City or Government-owned property.
    4. Existing Structures. Lawfully existing buildings, structures and antenna support structures on private property, provided that the buildings, structures or support structures are either: (1) located in a non-residential zone, or (2) located in a

residential zone on property that is being used for non-residential uses (e.g. government, school or church).

5. Monopoles on Non-residential Private Property. Monopoles constructed on private property, provided that the private property is (1) located in a non-residential and non-C-3 commercial zone, or (2) located in a residential zone on property that is used for a non-residential use (e.g. government, school or church).
6. Other. Sites other than those listed above.

B. Burden of Proof. The applicant shall attempt to locate its antennas on sites in the order of priority set forth above. If the applicant desires to locate antennas on a site other than the highest priority site, the applicant shall have the burden of demonstrating to the approving authority why it could not locate antennas on sites with a higher priority than the site chosen by the applicant. To do so, the applicant shall provide the following information to the approving authority.
    1. Higher Priority Sites. The identity and location of any higher priority sites located within the desired service area
    2. Reason for rejection of higher priority sites. The reason(s) why the higher priority sites are not technologically, legally or economically feasible. The applicant must make a good faith effort to locate antennas on a higher priority site. The City may request information from outside sources to justify or rebut the applicant's reasons for rejecting a higher priority site.
    3. Justification for proposed site. Why the proposed site is essential to meet the service demands of the geographic service area and the citywide network.

18.110.080 Uses

A. Permitted Uses
    1. Existing Structures on City-owned property. Existing buildings, structures and antenna support structures located on City-owned property.
    2. Industrial Zone. Monopoles, roof mounted, wall mounted, and stealth antenna on City, Government, or private property.
    3. Commercial Zones. Roof mounted antenna located on private or public property when the antenna is 5 feet or less in height.
B. Prohibited Uses. The following antenna types and antenna locations are not permitted:
    1. Residential Zones. All telecommunications facilities, including freestanding antenna, roof mounted antenna, wall mounted antenna, and stealth antenna on private property in residential zones
    2. Lattice Towers and Guy Towers. All freestanding towers, including lattice towers, guy towers, and other towers, with the exception of monopoles, are prohibited in any zone.
    3. Monopoles in Residential Zones on Private Property. All freestanding towers and monopoles located on residentially zoned private property, if the residentially zoned property has a residential use (as opposed to a school, church, or other non-residential use).
    4. Freestanding towers and monopoles in the C-3 Commercial Zone. All freestanding towers and monopoles are prohibited in the C-3 Commercial Zone.
C. Conditional Uses. The following are conditional uses:

1. Monopoles located in residential and commercial zones on City and Government owned property.
2. Monopoles located in commercial zones (except C-3 Commercial Zone) on private property.
3. Roof mounted antenna located in commercial zones on City, Government, and private property when the roof antenna exceeds 5 feet in height.
4. Wall mounted antenna located in commercial zones on City, Government, or private property.
5. Enclosed/Stealth antenna located in residential zones on City, Government, and private property containing non-residential uses.
6. Enclosed/Stealth antenna located in commercial zones on public and private property.
7. Antennas proposed for any other location, provided that the use is not prohibited by this ordinance, and the applicant complies with other applicable laws and regulations.

18.110.090 Co-Location

~~Unless otherwise authorized by the approving authority for good cause shown~~, Eevery new monopole shall be designed and constructed to be of sufficient size and capacity to accommodate at least two additional wireless telecommunications providers on the structure in the future. Any conditional use permit for a monopole may be conditioned upon the agreement of the applicant to allow co-location of other personal wireless providers on such terms as are common in the industry. Co-location on a lot may be permitted ~~by the Planning Commission~~ by the Planning Director or designee, if all setbacks, design and landscape requirements are met for each telecommunications facility. The application shall include any existing or approved, but unbuilt, telecommunications facility within the telecommunications area that may meet the needs of the applicant. The supplied documentation shall evaluate the following factors:

A. Structural capacity of the antenna towers;
B. Geographic telecommunications area requirements;
C. Mechanical or electrical incompatibilities;
D. Inability or ability to locate equipment on existing antenna towers; and
E. Any restriction or limitation of the Federal Communication Commission that would preclude the shared use of the antenna tower.

18.110.100 Lease Agreement

Applicants for telecommunication facilities on public facilities shall sign and agree to a development agreement with the public agency addressing items including, but not limited to access and security, maintenance of site and facilities, utility costs, and a fee for use of the public facility. The City shall enter into a standard lease agreement with the applicant for any facility built on City property. The lease shall contain the condition that the site plan and/or conditional use permit must first be approved by the ~~approving~~ designated land use authority before the lease can take effect, and that failure to obtain such approval renders the lease null and void.

18.110.110 Development Standards

Standards for Antennas and Antenna Support Structures. Personal wireless services facilities are characterized by the type or location of the antenna structure. There are four general types of antenna structures allowed by this ordinance: wall mounted antennas; roof mounted antennas; monopoles with no platform; and monopoles with a platform. If a particular type of antenna structure is allowed by this ordinance as a permitted or conditional use, the minimum standards for that type of antenna are as follows, unless otherwise provided in a conditional use permit:

A. Wall Mounted Antennas.
    1. Maximum Height. Wall mounted antennas may not extend above the roof line of the building or structure or extend more than twelve (12) inches from the face of the building.
    2. Setback. Wall mounted antennas shall not be located within one hundred feet (100') feet of any residence.
    3. Mounting Options. Antennas mounted directly on existing parapet walls, penthouses, or mechanical equipment rooms are considered to be wall mounted antennas if no portion of the antenna extends above the roof line of the parapet wall, penthouse, or mechanical equipment room.
    4. Color. Wall mounted antennas, equipment and supporting structures shall be painted to match the color of the building or structure or the background against which they are most commonly seen. Antennas and the supporting structure on the building shall be architecturally compatible with the building. Whip antennas are not allowed on a wall mounted antenna structure.
B. Roof Mounted Antennas.
    1. Maximum Height. Roof mounted antenna, placed on a flat roof, may extend up to ten (10) feet above the existing structure, provided that the antenna setback from the edge of the roof is a minimum distance equal to or greater than the height of the antenna. Roof mounted antenna, placed on a pitched roof, may extend a maximum of five (5) feet above the existing structure.
    2. Setback. Roof mounted antennas shall be located at least five feet (5') from the exterior wall of the building or structure, and at least fifty (50') feet from any residence.
    3. Mounting options. Roof mounted antennas may be mounted on top of existing penthouses or mechanical equipment rooms if the antennas and antenna support structures are enclosed or visually screened from view. The screening structure may not extend more than eight (8') feet above the existing roof line of the penthouse or mechanical equipment room.
    4. Color. Roof mounted antennas, equipment and supporting structures shall be painted to match the color of the building or structure or the background against which they are most commonly seen. Antennas and supporting structures shall be architecturally compatible with the building.
C. Monopoles with no Platform.
    1. Maximum Height and Width. The maximum height of the monopole or monopole antenna shall be thirty-five (35) feet. The entire antenna structure mounted on the

monopole shall not exceed two feet (2') in width. The antenna itself shall not exceed ten feet (10') in height.

2. Setback. Monopoles shall be set back a minimum of 115% of the height of the monopole from any residential lot line, measured from the base of the monopole to the nearest residential lot line.
3. Color. Monopoles, antennas, and related support structures shall be painted a neutral color. ~~, or a color to match the background against which they are most commonly~~

D. Monopoles with Platform.

1. Maximum Height and Width. The maximum height of the monopole or monopole antenna shall be thirty-five (35) feet. The antennas and antenna mounting structures on the monopole shall not exceed eight feet (8') in height or fifteen feet (15') in width. The antenna itself shall not exceed ten feet (10') in height.
2. Setback. Monopoles shall be set back a minimum of 115% of the height of the monopole from any residential lot line, measured from the base of the monopole to the nearest residential lot line.
3. Color. Monopoles, antennas, and related support structures shall be painted a neutral color, . ~~or a color to match the background against which they are most commonly seen.~~

~~18.110.120 Additional Conditional Use Permit Considerations~~

~~In addition to the City's standard conditional use permit considerations , the approving authority shall consider the following factors when deciding whether to grant a conditional use permit for a personal wireless services facility:~~

~~A. Compatibility. Compatibility of the facility with the height, mass and design of buildings, structures and uses in the vicinity of the facility.~~
~~B. Screening. Whether the facility is located relative to existing vegetation, topography and structures in a manner that optimizes visual screening.~~
~~C. Disguise. Whether the facility can be or has been disguised in a manner to mitigate potential negative impacts on surrounding properties.~~
~~D. Parcel Size. Whether the facility is located on a parcel of sufficient size to adequately support the facility.~~
~~E. Location on Parcel. Whether the structure is situated on the parcel in a manner that can best protect the interests of surrounding property owners, but still accommodate other appropriate uses of the parcel.~~
~~F. Compliance with Telecommunications Ordinance. Whether the proposed facility complies with the telecommunication facilities ordinance.~~
~~G. Compliance with General Plan. Whether the proposed facility complies with the intent, goals, and policies of the General Plan.~~
~~H. Compliance with the Underlying Zone. Whether the proposed facility complies with the intent, uses, and standards of the underlying zone and applicable supplemental zoning regulations.~~

18.110.13~~2~~0 Additional Regulations For Monopoles And Towers

A. Distance from other Monopoles. Monopoles and towers shall be located at least two thousand feet (2000') from each other, except upon a showing of necessity by the applicant, or upon a finding by the City Council that a closer distance would adequately protect the health, safety and welfare of the community. This distance requirement shall not apply to antennas attached to lawful structures such as transmission towers, utility poles, outdoor lighting structures, and water tanks.
B. Location on Parcel. Monopoles shall be located as unobtrusively on a parcel as possible, given the location of existing structures, nearby residential areas, and service needs of the applicant. Monopoles shall not be located in a required landscaped area, buffer area or parking area.

18.110.130 Area Limitations For Wall And Roof Mounted Antennas

Any building may have a combination of wall and roof mounted antennas. The total area for all wall and roof mounted antennas and supporting structures on any one building shall not exceed the lesser of sixty (60) square feet or 5 percent (5%) of each exterior wall of the building.

18.110.15~~5~~ 40 Safety

A. Regulation Compliance.
    1. Compliance with FCC and FAA Regulations. All operators of personal wireless services facilities shall demonstrate compliance with applicable Federal Communication Commission (FCC) and Federal Aviation Administration (FAA) regulations, including FCC radio frequency regulations, at the time of application and periodically thereafter as requested by the City. Failure to comply with the applicable regulations shall be grounds for revoking a site plan or conditional use permit approval.
    2. Other Licenses and Permits. The operator of every personal wireless services facility shall submit copies of all licenses and permits required by other agencies and governments with jurisdiction over the design, construction, location and operation of the facility to the City, shall maintain such licenses and permits in good standing, and shall provide evidence of renewal or extension thereof upon request by the City.
B. Protection Against Climbing. Monopoles shall be protected against unauthorized climbing by removing the climbing pegs from the lower 20 feet of the monopole.
C. Fencing. Monopoles and towers shall be fully enclosed by a minimum 6-foot tall fence or wall, as directed by the ~~City~~ Planning Director or designee unless the ~~City~~ Director determines that a wall or fence is not needed or appropriate for a particular site due to conditions specific to the site.
D. Security Lighting Requirements. Monopoles and towers shall comply with the FAA requirements for lighting. ~~As part of the conditional use permit consideration, the City may also require security lighting for the site.~~ If security lighting is used, the lighting impact on surrounding residential areas shall be minimized by using indirect lighting, where appropriate.
E. Abandonment. The applicant, or the applicant's successor(s) and/or assign(s) shall be responsible for the removal of unused telecommunications facilities within ninety (90)

days of abandonment of use. If such tower is not removed by the property owner, then the City may employ all legal measures, including as necessary, obtaining authorization from a court of competent jurisdiction, to remove the tower, and after removal may place a lien on the subject property for all direct and indirect costs incurred in dismantling and disposal of the tower, including court costs and reasonable attorney fees.

1. Notice. Notice to remove shall be given in writing by personal service, or by certified mail addressed to the operator's last known address.
2. Violation. Failure to remove the antennas and monopoles after receiving written notice to remove is a violation of the terms of this Chapter. The City may initiate criminal and/or civil legal proceeding against any person, firm, entity or corporation, whether acting as principal, agent, property owner, lessee, lessor, tenant, landlord, employee, employer or otherwise, for failure to remove antennas and monopoles in accordance with this Chapter. The City may seek a civil injunction requiring the removal of any structures on the site in accordance with this Chapter. Any lease agreement with the City may also stipulate failure to remove the antennas and monopoles after receiving written notice to do so pursuant to this Chapter automatically transfers ownership of the antennas, monopoles, support buildings and all other structures on the site to the City.
3. Nuisance. Abandoned, unmaintained, or telecommunication devices that pose an immediate threat to public health and safety are hereby declared to be a nuisance.

18.110.16~~5~~0 Site Requirements

A. Setbacks. The placement of telecommunications facilities on a lot shall comply with the setbacks of the underlying zone as stated herein. Telecommunications facilities shall comply with the setbacks for main structures and shall not be determined accessory structures.
B. Use of Property. The telecommunications facility shall be an ancillary use on the lot on which it is placed. The lot shall contain a separate principal use.
C. Regulations for Accessory Structures.
    1. Storage Areas and Solid Waste Receptacles. No outside storage or solid waste receptacles shall be permitted on the site.
    ~~2.~~ Equipment Enclosures. All electronic and other related equipment and appurtenances necessary for the operation of any personal wireless services facility shall, whenever possible, be located within a lawfully pre-existing structure or completely below grade. ~~When a new structure is required to house such equipment, the structure shall be harmonious with, and blend with, the natural features, buildings and structures surrounding such structure. Equipment Shelters located outside of an existing building shall require a conditional use permit approval from the Planning Commission for compliance with the Design Compatibility. The Planning Commission shall make a finding that the equipment in or shelter for equipment, meets the Design Theme and is in compliance with 17.38.050 Design Requirements, and Architectural Design Guidelines, if applicable, or Heber City Design Guidelines.~~

3. Accessory Buildings. Freestanding accessory buildings used with a personal wireless services facility shall not exceed 350 square feet and shall comply with the setback requirements for structures in the zone in which the facility is located.

D. Parking. The City may require a minimum of one (1) parking stall for sites containing a monopole, tower, and/or accessory buildings, if there is no parking available on the site.
E. Maintenance Requirements. All personal wireless services facilities shall be maintained in a safe, neat and attractive manner.
F. Landscaping. All sites with a personal wireless services facility shall be landscaped in accordance with the zone requirements where the facility is located.
G. Height. The height shall be measured from the grade or roof beneath to the top of the antenna or mounting hardware, whichever is higher.
H. Design ~~Compatibility.~~
    ~~1.~~ Antenna and associated equipment shall incorporate materials and colors present in the context of the surrounding area. Stealth telecommunications facilities shall be designed in a manner to blend with the existing and natural environment. Monopoles, antennas, and any associated buildings or equipment shall be painted to blend with the surroundings. ~~which they are most commonly seen. The color shall be determined on a case-by-case basis by the Planning Commission for conditional uses and the Planning Department for permitted uses. Within six months after the facility has been constructed, the planning commission or the Planning Department may require the color be changed if it is determined that the original color does not blend with the surroundings.~~
    2. Panel Antennas shall be no more than five square feet (5 sq. ft.) in Area per face.

18.110.17~~6~~0 Site Disturbance

Any application, temporary or permanent, which requires the removal of significant vegetation or proposes any new, or improvements to driveways or roads a length greater than twenty feet (20') and/or a width greater than ten feet (10') wide, shall require a conditional use permit. As used herein, "Significant Vegetation" includes trees six inch (6") in diameter or greater measured four feet six inches (4'6") above the ground, groves of small trees or clumps of oak and maple covering an Area of twenty square feet (20 sq. ft.) or more measured at the drip line. Plans must show all such trees within twenty (20) feet of a proposed telecommunications facility. The Planning ~~Department~~ Director or designee shall determine the Limits of Disturbance. ~~and may require mitigation for loss of Significant Vegetation.~~

18.110.18~~7~~0 Signs

Signs shall only be permitted if they are related to the health and safety of the general public. All proposed signs shall be submitted with the telecommunications facility application and subject to review by the Planning Department for compliance with Chapter 18.104~~3,~~ Sign Regulations.

18.110.19~~8~~0 Subdivision And Condominium Covenants

Many Subdivision and Condominium Covenants may address the location of telecommunications facilities within Condominium units and the lots of a Subdivision. The City

is not a party to those covenants, and no permit from the City shall effect the enforceability of such covenants which might be more restrictive than this ordinance. Applicants for the installation of telecommunications facilities are advised to determine what private land use restrictions apply to their site before applying for the permit from the City. If the proposed installation is within the Common Area of a Condominium or Planned Unit Development, and the application submitted is not in the name of the Home Owner's Association or management committee, the applicant shall provide a letter from the Home Owner's Association or management committee indicating consent to the location of the telecommunications facilities within the Common Area has been granted as a part of the permit application filed with the City.

~~18.110.200 Expansion, Alteration, And Nonconforming Uses~~

~~This ordinance shall not make existing, non-conforming and/or illegal telecommunication facilities legal or conforming. Any expansion or alteration of a telecommunications facility shall comply with the provisions and procedures of this ordinance. Expansion and alteration include any change to the facility, including but not limited to structural, electrical, aesthetic and functional changes. Non-conforming telecommunication facilities, when expanded or altered, shall meet the requirements of this ordinance.~~

- ~~A. Any pre-existing facilities located in a commercial or industrial zone which were placed without a building permit prior to the effective date of this ordinance may apply for a building permit and be approved if the facility meets the application height, setback and location provisions of this ordinance, subject to Section 18.110.070.~~
- ~~B. Existing, illegal facilities which cannot or do not meet the height, setback, and location provisions of this ordinance may apply to the Board of Adjustment for a special exception. The Board may approve such an exception, only upon condition it meet all of the following findings:~~
    - ~~1. That the existing facility was erected prior to the effective date of this ordinance.~~
    - ~~2. That the existing facility is compatible, aesthetically and otherwise, with the surrounding uses.~~
    - ~~3. That the facility does not present a prominent position by itself to the skyscape, as viewed from the public street, and if so, that said facility may be moved within the site to a position so as not to be visibly prominent in the skyscape.~~
    - ~~4. That the facility is currently being used and has not been abandoned for a period longer than that allowed by Section 18.110.150 E, of this ordinance.~~
- ~~C. The Board may place any additional conditions of approval it may deem fit and advisable to safeguard the aesthetics of the community as viewed from the public street.~~
- ~~D. As part of the Conditional Use permit approval for modification of an existing monopole, the Planning Commission may waive the height and setback requirements for approved co-location monopoles in existence prior to this ordinance which are located within the I-1 Industrial Zone.~~

~~18.110.210 Telecommunication Facilities To Permit, As A Conditional Use, A Radio Antenna~~

~~The following use shall be permitted, as a Conditional Use, in the C-3 Central Commercial Zone:~~

~~A. A radio antenna may be constructed with a maximum height of 50 feet from ground level, with a minimum setback of 50 feet from main Street, and a minimum setback of 50 feet from any residential zone.~~

~~B. Any antenna devices, weather sensing facilities or sending and receiving secondary antennas shall be located on the antenna near the top of the roof of the associated studio building so as not to be observable from Main Street. In no event shall any such antennas or facilities be higher than 50 feet from ground level.~~

Planning Commission Staff Report

MEETING DATE:	August 13, 2022
SUBJECT:	Sensitive Lands Ordinance
RESPONSIBLE:	John Janson, People & Place Consultant
DEPARTMENT:	Planning Department
STRATEGIC RELEVANCE:	Community Development

SUMMARY

As part of the Phase 3 Envision Heber Code Update, the Planning Commission is reviewing the entire Code and Subdivision Ordinance. As part of that process the current sensitive lands section found in Subdivision Ordinance, 17.34.010 will become its' own chapter, since such lands can also impact a permitted or conditional use application. Over the next six to nine months more updates and revisions will be presented until the entire Code has been updated/revised.

This work session report explores the existing code section and two draft sensitive lands ordinances – one from the Open Space Committee and one that was acted on by the Planning Commission some time ago.

RECOMMENDATION

Staff recommends the Planning Commission study the existing and proposed drafts and consider making a recommendation to the City Council after a public hearing, tentatively scheduled for September.

BACKGROUND

Envision Heber Phase 3, includes updates, simplifications and clarifications in most of the Code chapters.

These ordinance amendments are a result of the contract with People + Place, John Janson, Meg Ryan and the Planning Department staff. The proposals within the drafts include policy suggestions, State Law updates, and edits for greater clarity. It is also the intent of these updates to simplify the ordinances, and to refer to the Heber City Standard Specifications instead of listing engineering requirements in the Zoning Ordinance.

The existing code and the drafts are included at the end of this report, but here is a comparison of the existing and proposed drafts:

Comparisons

17.34.010 Existing Sensitive Lands Ordinance	Draft Open Space Committee Recommendation	Draft Planning Commission Recommendation	Consultant comments
Missing Purpose	Purpose – adds protection of the Class 1A aquifer, water quality, and recharge areas	Purpose	Update to emphasize the Underground Aquifer
Missing Applicability	Applicability - same	Applicability - same	Broadened in drafts to apply to any undeveloped property not in a processed sub
Missing Definitions	Definitions – adds new section of definitions Includes the same list of SLs but adds detail for "significance" – historic/cultural, sense of place, viewsheds, adjacent sensitive lands	Definition – list of topics to be addressed – not really definitions per se	Could be pared down Significance details seem too subjective – how are they determined?
Missing Identification	Identification - same	Identification - same	Requires designing SL features into a project. Emphasizes a design process/philosophy
Missing but some found in other Code provisions	Development Design Considerations – adds grading plan for the final plat in addition to preliminary Adds more detail for construction close to the water table Contamination assurances Revegetation/Landscape plan required	Development Design considerations - Grading plans at concept, LID, SWPPP, UPDES Geotech reports required View sheds Trails continuations and connections Cuts and fills	New drafts provide more detail on what information is expected Grading plan provided at preliminary
Development Prohibited – slopes over 30% avalanche tracks Fault lines (scarps, landslides, rock outcropping, rock-fall, mud/debris flows) Stream beds, canals, ditches, flood channels, areas of springs, seeps and surface water	Development Prohibited – adds a 25' buffer to the fault line section All water features to have a 75' buffer Canals to have a 35' buffer Wetlands 75' buffer WUI Culinary water sources Ridgelines and viewsheds Adds Lakes, Ponds, and Reservoirs to have a 100' buffer	Development Prohibited – Slopes over 30% (buildable areas, erosion, terracing, revegetation) Avalanche paths Fault line related (scarps, landslides, rock outcropping, rock-fall, mud/debris flows) Stream beds, canals, wetlands – 50' buffers WUI Canals Wetlands – 50' buffer	Similar lists but more detail in new drafts

		Culinary water source protection Ridgelines View sheds	
Development discouraged – soil related Shallow ground water Flood Zones Culinary water source protection	Development Constraints – Adds consulting with County Health and contamination assurances	Development Constraints – Soil related shallow groundwater flood zones	The term development "discouraged" doesn't really mean much. Development "constrained" suggests you can develop these lands but they will need mitigations.
Missing Preservation Instruments	Preservation Instruments - same	Preservation instruments - same	Describes acceptable ways to preserve SLs, requires maintenance of preserved areas
Missing Density Transfers	Density Transfers - same	Density Transfers - same	Only addresses slope – may want to broaden this allowance. Only allows transfers to other parts of the City – may want to consider clustering
Missing notifications	Notifications to adjacent proposed development - same	Notifications to adjacent proposed development - same	
Missing – other considerations	Other Considerations – same except adds the scrub oak, maple and large trees back in	Other Considerations - Wells and springs, LID, heritage trees, species protection/migration areas, plat notification for developments adjacent to ag lands	Earlier drafts included provisions for a certain area/size of scrub oak/maple groves for preservation

DISCUSSION

Since this is a work session and since the PC draft was tabled by the CC, a revised draft is needed. Comments from the joint meeting with the City Council included such thoughts as:

Do we really need more than we have already in 17.34.010? (see table comparison)
Have we gone so far that most developments will not be able to build?
Have we covered the important items or simply too many items?
Is it clear what our expectations are?
Should developers be compensated for sensitive lands that they avoid? Most likely a density increase or reduced standards to allow for clustering?
How can we make this a positive ordinance?

Comparing the suggested drafts may be partially accomplished via the table above. More detail can be found in the drafts provided below.

One simple means of making this ordinance more developer friendly, is to provide more density bonuses for the lost land within the development. One could argue that the sensitive lands should never have been built on and therefore should not provide the developer with additional units, but most sensitive lands (with some exceptions), actually have ways that the issue could be mitigated. We discuss some of those mitigation techniques in the draft.

In the PC draft, possible areas for density bonuses are highlighted in yellow.

FISCAL IMPACT

N/A

CONCLUSION

N/A

ALTERNATIVES

N/A

POTENTIAL MOTIONS

N/A

ACCOUNTABILITY

Department: Planning Department, Planning Director
Staff Member: Anthony L. Kohler

EXHIBITS

<u>17.34.010 Sensitive Lands</u> (current ordinance)

1. **Development Prohibited**. New subdivisions and new development shall avoid the following areas:
    1. Natural slopes over thirty percent (30%) grade; each lot must have a contiguous building area that is a minimum of five thousand (5,000) square feet at or below thirty percent (30%) natural grade;
    2. Avalanche tracks;
    3. Fault lines, scarps, landslides, rock-fall and mudflow areas; and
    4. Stream beds, canals, ditches, flood channels, areas of springs, seeps and surface water.
2. **Development Discouraged**. The following hazard areas should be avoided by new subdivisions and new development and developer shall provide mitigation for such hazards when they apply. The city may require a notice of such hazard and required mitigation to future property owners in a development agreement, subdivision plat or other device.

1. Alluvial-fan-flood debris flow, collapsible soils, and shrink-swell soils. Mitigation techniques shall follow the advisement of a qualified Geotechnical Engineer.
2. Shallow ground-water. Mitigation techniques should include the installation of a foundation drain and sump pump, prohibition of basements, or the advisement of a qualified Geotechnical Engineer.
3. 100 year flood zones. Mitigation techniques shall follow the procedures of Chapter 18.109 Flood Damage Prevention Ordinance.
4. Culinary Water Source Protection. Mitigation techniques shall follow the advisement of the source delineation report, current engineering practice, and/or applicable state statutes.

Open Space Committee Draft Recommendation

August 28, 2021

_____

17.34.010 Sensitive Lands, Hazards, and Agricultural Land Notification
A. Purpose and Intent:

1. To preserve the distinctive features and the natural setting characteristic of Heber City and to promote development that is sensitive to the land.
2. To maintain & protect the Class 1A Aquifer, surface water quality, and aquifer recharge areas within Heber City & Valley.
3. To identify and document sensitive lands that shall be protected from development and to guide sensitive lands related open space designations in development proposals.
4. To identify certain hazardous conditions that require buffering or other engineering techniques to allow for safe beneficial development.
5. To give notice and promote an understanding of property owners with development proposals adjacent to agricultural uses of the characteristics of those agricultural uses.
6. To provide for the health, safety, welfare of the citizens, as well as protect urban and nonurban development, the good order and aesthetics of our municipality, and protection of property values with these sensitive land protections per U.C.A. 10-9a-102(1).
7. Definitions per U.A.C. (Utah Administrative Code R317-6 *Ground Water Quality Protections* & R309-600-6(1)(x) & (z)(bb) *Definitions* & U.C.A:

Aquifer means a geologic formation, group of geologic formations or part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs.

CLASS IA Aquifer - PRISTINE GROUND WATER; Class IA ground water has the following characteristics:

a. Total dissolved solids of less than 500 mg/l.
b. No contaminant concentrations that exceed the ground water quality standards listed in Table 1, Utah Administrative Rules 317-6-2.1.

Ground Water means subsurface water in the zone of saturation including perched ground water.

Heritage Tree means, per U.C.A. 65A-8-302(4): any tree or group of trees designated as such by the division, in accordance with the following criteria:

(a) any live tree or group of trees indigenous to the state, or which has adapted exceptionally well to the climatic conditions of the state, or is one of a kind;

(b) any tree or group of trees that has exceptional national, state, or local historic significance;

(c) any tree or group of trees which has an exceptional size or exceptional form for its species;

(d) any tree or group of trees which has an exceptional age for its species; or

(e) any tree or group of trees in the state which is the sole representative of its species.

Perched Groundwater means Groundwater separated from an underlying body of groundwater/aquifer by an unsaturated zone.

Protected Aquifer means a producing aquifer in which the following conditions are met:

a. A naturally protective layer of clay, at least 30 feet in thickness, is present above the aquifer;

b. the clay layer is demonstrated to be laterally continuous to the extent of zone two, and;

c. the public-supply well is grouted with a grout seal that extends from the ground surface down to at least 100 feet below the surface, and for a thickness of at least 30 feet through the protective clay layer.

Sensitive Area/Lands means those areas that are located near residences, waters of the state, wetlands, or any area where exposure to humans or significant environmental impact is likely to occur.

Unprotected Aquifer means any aquifer that does not meet the definition of a protected aquifer.

Water Table means the top of the saturated zone of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

Zone Two is the area within a 250-day ground-water time of travel to the wellhead, the boundary of the aquifer(s) which supplies water the ground-water source, or the ground-water divide, whichever is closer (See Chapter 8.28.030).

B. Applicability. Although this Ordinance is part of the subdivision process, the requirements contained herein shall be extended to individual lots not requiring a subdivision process, or not previously subject to a subdivision process that included the requirements of this Municipal Code Chapter and/or processed after the date of adoption of this Chapter. In addition, any annexation proposal, Master Development Agreement, concept plans, preliminary plans, and final plans shall include a sensitive lands identification analysis or other plans that addresses the requirements of this Ordinance.

C. **Sensitive Lands defined**. Sensitive Lands contain characteristics that can influence, modify, or limit development patterns through physical or regulatory restrictions. The types of lands

represented in this typology include steep slopes, significant rock outcroppings, wetlands, avalanche zones, intermittent or constant flow stream corridors, ridgelines, springs, significant gullies, species protection, wildfire/urban interfaces, flood plains, animal migration routes, heritage trees, large trees, and oak and maple groves. Soils and geotechnical considerations, such as fault lines, soil types, and depth to bedrock, and shallow water table levels, may also reveal factors to consider for avoidance and/or design modifications when determining the extent of sensitive lands. Significant is defined for the entire preceding list as: 1- historically or culturally important areas; and/or 2- an important characteristic of community providing a sense of place; and/or 3- part of viewshed from state highways; and/or 4- includes other sensitive lands within 50 feet; to preserve the historical character of Heber City and Valley and sense of place.

D. Identification required. Designation and preservation of the identified Sensitive Lands features and their associated area (s) in their natural state is required and such sensitive lands shall be shown in concept plans, site plans, and preliminary and final subdivision plats (applications on-line and at the City offices). It is the intent of these requirement to promote a development design that incorporates and integrates the sensitive lands into the development design process as valued aspects of that design. These characteristics need identification and are significant factors that determine how sensitive lands should be reflected in the design of a particular development site.

E. Development Design Considerations.

1. All preliminary, concept & final plans shall include a grading plan to assure that the development minimizes land disturbance, that erosion and storm water are contained on-site, and conforms to any City standards (see also City Code 17.20.020.N), especially Low Impact Development techniques and Storm Water Pollution Prevention Plans (SWPPP) to protect the Class 1A Aquifer, surface water and aquifer recharge areas. Storm drainage plans shall include system design to return filtered waters to the natural drainage channels and provide detention within. All developments shall provide evidence of their Utah State Department of Environment Quality General Construction Stormwater UPDES Permits at building permit issuance.

2. Geotechnical reports shall also include an analysis of the soil types and their potential for movement when additional water is applied, as may occur from landscape irrigation and/or impervious surface runoff. Geotechnical studies shall also identify (1) the depth to water table, and (2) fluctuations in seasonal water tables; (3) whether the water table is 10 feet deep or less; (4) and whether shallow groundwater is perched or part of an aquifer; (5) and if any part of the proposed buildings are within the water table or within three feet of water table, such as basements, parking areas, foundations, etc.

Also, City Engineer/other City Departments can consult with County Health Department for water quality concerns. Additional Geotechnical information may be requested by other City Departments (see also City Code 17.20.020.N(3) & (4)). In the absence of a yearlong analysis of water table fluctuations, the time period to be studied is from March 15 to June 15. All geotechnical reports must include assurances from engineer that any designed improvements being recommended will not contaminate the waters of Utah State per U.A.C. R317-6-4-2(A).

3. Critical view sheds should be evaluated for State Highway rights-of-way and corridor buffers established, to preserve the character of the Heber Valley.

4. After identifying/document (or delineating in the case of wetlands) any sensitive lands as defined above, and reviewing the Heber City's General Plan and Parks, Trails, and Open Space Master Plan, and the Wasatch County Regional Trails Master Plan for trails, as part of the design process of a development and as part of the concept plan submission, each development shall include a conceptual, preliminary, and final design to assess how the development will be designed to preserve the identified sensitive lands and evaluate the potential to extend trail systems to and within the area.

5. Development shall mitigate the visibility of cuts and fills and buildings on hillsides that are visible from the viewing platforms identified in the ridgeline protection ordinance in Section 18.106.050. Mitigation shall include methods to conceal such cuts and fills and buildings, such as evergreen landscaping, hill terracing, use of earth-tone colors on structures, utilizing narrower street cross sections along steep slopes, moving streets, etc., as part of the submitted landscaping plan and revegetated within one year.

F. Development Prohibited. New subdivisions and new development shall avoid and preserve as undisturbed/natural open space the following areas:

1. *Steep slopes:* Identify areas with average slopes ranging from 10% to 20% and from 20% to 30%. Slopes over 30% are prohibited from development unless a lot has a contiguous building area that is a minimum of five thousand (5,000) square feet at or below thirty percent (30%) natural grade. All such lots shall include specific engineering designs to contain run off, erosion, and pollution on the subject property during construction and after construction, which shall protect the Class 1A Aquifer, surface water, and preserve the historical character of Heber City and Valley, and sense of place.
This includes the prevention of any materials caused by erosion flowing out onto adjacent trails, sidewalks and streets, adjacent fences, and erosion onto the sensitive lands buffer areas. Cuts and fills shall be avoided in project design to the greatest extent possible and shall not exceed a 2 to 1 slope. Retaining walls extending over 6' in height shall include a landscaped terrace, a minimum of 4' in width for every 6' in height. Terraces maybe created at lesser heights to meet slope related issues, but the minimum number based on the 6' interval shall be maintained. Development in all steep sloped areas (20% and above) shall submit plans that conform to any City Standards, utilize Low Impact Development techniques, and specialized storm water permits such as SWPPP. Home development in the 20% to 30% slope category shall be limited to 1.5 stories. Revegetation with native plants of disturbed areas is required within 6 months for any grading performed for road work and after the occupancy of a home.

2. *Avalanche paths:* Such avalanche paths shall be identified, and development shall avoid such paths as recommended by a qualified Geotechnical Engineer.

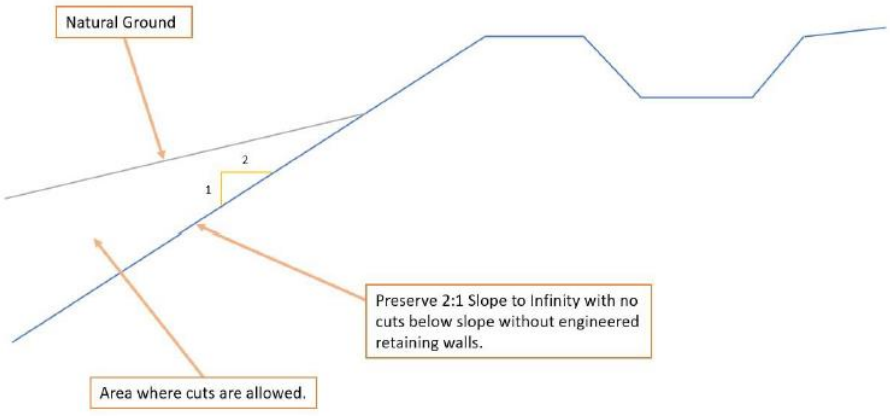
3. *Fault lines, scarps, landslides, rock outcroppings, rock-fall, and mud/debris flow areas* (see also gullies in Section C above): These topographical features shall be avoided and mitigated as recommended by a qualified Geotechnical Engineer. These topographical features shall be

buffered on all sides with a minimum of 25' undisturbed natural area or as determined in a geological report to protect the Class 1A Aquifer, surface water, preserve the historical character of Heber City and Valley and sense of place. Mitigation techniques shall follow the advisement of a qualified geotechnical engineer. Determinations and mitigation techniques proposed that, when analyzed by the City Engineer, do not clearly resolve any identified issues may be subject to peer review at the City's discretion. The developer shall pay for such additional studies/peer reviews and the City shall manage the funds.

4. *Stream beds (including intermittent), gullies, ditches, flood channels, flood plains, areas of springs, and seeps*: These hydrological features require a 75' minimum width buffer from each edge to protect the Class 1A Aquifer, surface water, and preserve the historical character of Heber City and Valley, and sense of place. These features shall be delineated in all reports. If pollution sources such as fuel tanks, buildings, non-permeable surfaces, parking lots, septic tanks, etc. are proposed adjacent to these hydrological features and/or public or private wells, the required setback is a total of at least 100 feet from the pollution source to the hydrologic feature (see also Drinking Source Protection, Chapter 8.28). Additional vegetation may be required in the buffer areas between the hydrologic features and development for erosion control (with no fertilizer or pesticide use allowed) or for public amenities.

5. *Canals.* Development shall avoid destabilizing the downhill portion of canals, as may be requested by canal companies, or as may be determined by the City Engineer in the absence of a canal company standard. No cuts shall be permitted below a 2:1 slope measured from the downhill bank of a canal without an engineered retaining wall. Under no condition shall the setback from the canal edge be less than 35 feet. Any canal improvements shall include required buffers and trail improvements, including trail access points and other required amenities. Such canal improvement shall protect water quality and preserve the historical character of Heber City and Valley and sense of place. See graphic below "Canal Bank Stabilization".

Canal Bank Stabilization



6. *Identified wetlands*: Identified wetlands shall be delineated using the Section 404 definition and procedures within the Clean Water Act. All identified wetlands will require a 75 feet minimum undisturbed buffer around edge of wetlands to preserve the Class 1A Aquifer, surface water, and the historical character of Heber City and Valley and sense of place. If pollution sources such as fuel tanks, buildings, non-permeable surfaces, parking lots, septic tanks, etc., are proposed adjacent to identified wetlands, the required setback is a total of at least 100 feet from the pollution source to the hydrologic feature (see also Drinking Source Protection, Chapter 8.28). Additional vegetation may be required in the buffer areas between the hydrologic features and development for erosion control (with no fertilizer or pesticide use allowed) or for public amenities.

7. *Wildfire Potential: Potential wildfire areas shall* be assessed, and mitigation strategies applied, as per Chapter 15.04.010 D.

8. *Culinary Water Source Protection. Public and private wells, and springs*: Such areas shall be identified within the subject property and on adjacent properties within 100'. City required notification processes shall be followed. Mitigation techniques shall follow the advisement of the source delineation report, current engineering practice, applicable state statutes, and contain all erosion and site pollution, within the development. See Drinking Water Protection, Chapter 8.28.

9. *Ridgeline Protection*: Development above ridgelines shall follow the standards in Chapter 18.106, Ridgeline Protection.

10. *View sheds:* Where new development is proposed along State roads lacking adjacent scenic buffers, **or** trail corridors, or adjacent 10 acre/larger agricultural zoning; the viewshed impacts shall be considered and protected with buffers including additional landscaping, setbacks, and parallel trails defined as part of the site plan, preliminary, and final plans to preserve the historical character of Heber City and Valley and sense of place.

11. *Lakes, Ponds, Rivers, and Reservoirs.*

All Lakes, Ponds, & Rivers, will require a 100' minimum undisturbed buffer from the high-water mark around all edges of the water body to protect the Class 1A aquifer, the historical character of Heber City and Valley and sense of place. Additional vegetation may be required in the buffer areas between the hydrologic features and development for erosion control (with no fertilizer or pesticide use allowed) or for public amenities. This includes man-made hydrological features. Docks can be considered as additional allowed amenities.

G. Development Constraints for Certain Sensitive Lands. The following sensitive land with potential hazards requires additional mitigation techniques in new subdivisions and new development, and the developer shall provide mitigation for such hazards when they apply. The City requires a notice of such hazard and required mitigation to future property owners in a development agreement, on the subdivision plat and/or other device. Such additional

mitigation techniques shall include, (practicable or available) but not be limited to the following:

1. Alluvial-fan-flood debris flow, collapsible soils, and shrink-swell soils. Mitigation techniques shall follow the advisement of a qualified Geotechnical Engineer and may be subject to peer review, at the developer's cost.

2. Shallow groundwater. As part of a geotechnical study/report, the depth of the water table shall be assessed in a year-long study or a March 15 to June 15 assessment that determines whether the water table is 10 feet deep or less from the surface; and whether shallow groundwater is perched or part of an aquifer, and if groundwater is initially identified at depths less than 3 feet from the surface, and if any part of the proposed buildings are within the water table or within (3) three feet of water table; such as basements, parking areas, foundations, etc. Development may be denied if groundwater is demonstrated to be three feet or less any time during the year to protect the Class 1A aquifer and surface water. If the water table is subject to area irrigation practices, the minimum time period for study is March 15 to August 15. During drought conditions, defined as 80% or below normal average precipitation, such studies shall provide an estimate of the rise in the water table if normal precipitation were to occur and at 110% of normal. If areas of shallow ground water are found that prohibit or impact foundations, such areas shall be noted in the concept design and carried forward on the preliminary and final plats. Possible mitigation techniques include the installation of a foundation drain(s) and sump pump(s), possible prohibition of basements, or other mitigation techniques as provided on the advisement of a qualified Geotechnical Engineer and/or upon consultation with County Health Department. Areas with ground water within 3' of the surface, shall require additional analysis to assess their feasibility for development. Also, City Engineer/other City Departments can consult with County Health Department for water quality concerns. All geotechnical reports must include assurances from engineer that any designed improvements being recommended will not contaminate the waters of Utah State per U.A.C. R317-6-4-2(A).

3. 100-year flood zones. Mitigation techniques shall follow the procedures of Chapter 18.109, Flood Damage Prevention Ordinance.

H. Acceptable Permanent Sensitive Land Preservation Instruments. Such areas shall be preserved through a conservation easement, R lot designation, dedicated as accessible public open space to the City with a conservation easement, deed restricted with an HOA maintenance commitment, or other means that assure permanent preservation. Such areas shall include public access points, where trails are included in the preserved sensitive lands. Preservation techniques shall be negotiated as part of a development agreement.

I. Sensitive Lands Preservation Incentives through Density Transfers. Developers are encouraged not to build on slopes of 20 percent or greater. To this end, for slopes of 20 percent or greater, the applicant may ask the City to consider transfer of potential steeper area lots to other areas of the city, with a corresponding increase in density or to transfer, via a TDR-like mechanism, to identified receiving areas in the City consistent with the zone. Such transfers shall be implemented and established through negotiation with the City Council in a development agreement.

J. Developments including or adjacent to Sensitive Lands shall include restrictive covenants with mitigation techniques for the continued maintenance, recorded documents that require preservation in perpetuity, and enhancement of Sensitive Lands and their associated open spaces.

K. Other Considerations.

1. Buried wells, springs, and streams. Existing development may have capped old wells and springs, or piped streams which could have potential cultural and historical value. If significant redevelopment of the site's structures, defined as over 50% of the building is being modified or replaced, efforts to re-establish an open stream or utilize the spring or well as a water feature, shall be considered in the design process. Buried/capped wells may be impractical to reestablish.

2. Low Impact Development (LID) Storm Water Erosion and Pollution prevention techniques: A LID Storm Water Report/Implementation techniques plan, to be prepared by a person or firm qualified by training and experience to have expert knowledge of the subject, shall be prepared according to State and City Standards and generally include the following:

a. An analysis, including calculations and implementation rationale for possible LID Best Management Practices that could be implemented on the site:
1) To improve the water quality and reduce the quantity of storm water generated from a development, on-site stormwater management shall meet or exceed approved City standards with encouragement to exceed standards.
2) To provide methods of retention which would include infiltration, evaporation, transpiration, rainwater harvesting and re-use, and as specified by City standards.
3) For the preservation and enhancement of native vegetation in areas where storm water is being introduced. This shall be required as this vegetation retains, intercepts, and transpires storm water, but may be modified as design considerations are considered.

3. Heritage Trees: Heritage Trees as designated by the Utah Heritage Tree Act and administered by the Utah Department of Natural Resources shall be preserved according to State Law**.**

4. Species protection/animal migration areas: Identify habitat areas (especially habitat for the sage grouse and spotted frog) in the concept, preliminary, and final plans and in conjunction with other sensitive lands consider preservation, with the understanding that with some areas such anticipated preservation may be impractical based on the development design. Identified animal migration corridors may be replaced with a highly landscaped trail corridor (s).

5. Development adjacent to agricultural lands shall provide a recorded notification on the subdivision plat and/or other device, informing subsequent purchasers of the property of the potential for noise, odors and other characteristics involved in living adjacent to agricultural operations.

6. Scrub Oak, Maple Groves, and Large Trees: These trees and vegetation shall be identified, preserved to the greatest extent possible, and designed into the project submittal. Such groves

or large tree preservation may need modification after consideration of financial costs or design/amenity-based strategies; yet should preserve the historical character of Heber City and Valley and sense of place.

References for Above Code:

Utah Administrative Code, **R317-6. Ground Water Quality Protection & R309-600-6(1)(w)**. Search at:

https://adminrules.utah.gov/public/search/ground%20water/Current%20Rules

Heritage Tree Code, in U.C.A.: https://le.utah.gov/xcode/Title65A/Chapter8/65A-8-S302.html?v=C65A-8-S302_1800010118000101

Proposed Sensitive Lands Ordinance

As Recommended by the Planning Commission on July 13, 2021 with minor additions and yellow highlights for potential density transfers

17.34.010 Sensitive Lands, Hazards, and Agricultural Land Notification

A. **Purpose and Intent**:

1. To preserve the distinctive features and the natural setting characteristic of Heber City and to promote development that is sensitive to the land.
2. To identify and document sensitive lands that shall be protected from development and to guide sensitive lands related open space designations in development proposals.
3. To identify certain hazardous conditions that require buffering or other engineering techniques to allow for safe beneficial development
4. To give notice, and promote an understanding of property owners with development proposals adjacent to agricultural uses of the characteristics of those agricultural uses.
5. To provide for the health, safety, welfare of the citizens, as well as protect urban and nonurban development, the good order and aesthetics of our municipality, and protection of property values per U.C.A. 10-9a-102(1).

B. **Applicability**. Although this Ordinance is part of the subdivision process, the requirements contained herein shall be extended to individual lots not requiring a subdivision process, or not previously subject to a subdivision process that included the requirements of this Municipal Code Chapter and/or processed after the date of adoption of this Chapter. In addition, any annexation proposal, Master Development Agreement, concept plans, preliminary plans, and final plans shall include a sensitive lands identification analysis or other plans that addresses the requirements of this Ordinance.

C. **Sensitive Lands defined**. Sensitive Lands contain characteristics that can influence, modify, or limit development patterns through physical or regulatory restrictions. The types of lands represented in this typology include steep slopes, significant rock outcroppings, wetlands, avalanche zones, intermittent or constant flow stream corridors, ridgelines, springs,

significant gullies, species protection, wildfire/urban interfaces, flood plains, animal migration routes, heritage trees, and oak and maple groves. Soils and geotechnical considerations, such as fault lines, soil types, and depth to bedrock, and shallow water table levels, may also reveal factors to consider for avoidance and/or design modifications when determining the extent of sensitive lands.

D. **Identification required.** Designation and preservation of the identified Sensitive Lands features and their associated area (s) in their natural state is required and such sensitive lands shall be shown in concept plans, site plans, and preliminary and final subdivision plats (applications on-line and at the City offices). It is the intent of these requirement to promote a development design that incorporates and integrates the sensitive lands into the development design process as valued aspects of that design. These characteristics need identification and are significant factors that determine how sensitive lands should be reflected in the design of a particular development site.

E. **Development Design Considerations.**

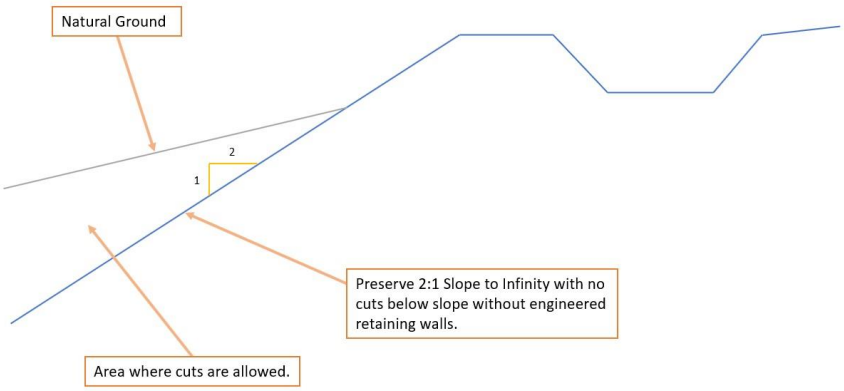
1. All preliminary/concept plans shall include a grading plan to assure that the development minimizes land disturbance, that erosion and storm water are contained on-site to the greatest extent possible, and conforms to any City standards, especially Low Impact Development techniques and Storm Water Pollution Prevention Plans (SWPPP). Storm drainage plans shall include system design to return filtered waters to the natural drainage channels and provide detention within. All developments shall provide evidence of their Utah State Department of Environment Quality General Construction Stormwater UPDES Permits at building permit issuance.
2. Geotechnical reports shall also include an analysis of the soil types and their potential for movement when additional water is applied, as may occur from landscape irrigation and/or impervious surface runoff. Geotechnical studies shall also identify (1) the depth to water table, and (2) fluctuations in seasonal water tables, if buildings with basements are to be constructed within the proposed development or if due to specific circumstances the County Health Department or City Departments requests the information. In the absence of a year-long analysis of water table fluctuations, the time period to be studied is from March 15 to June 15.
3. Critical view sheds should be evaluated for State Highway rights-of-way and corridor buffers established, to preserve the character of the Heber Valley.
4. After identifying/documenting (or delineating in the case of wetlands) any sensitive lands as defined above, and reviewing, Heber City's General Plan and Parks, Trails, and Open Space Master Plan, and the Wasatch County Regional Trails Master Plan for trails, as part of the design process of a development, and as part of the concept plan submission, each development shall include a conceptual design to assess how the development will be designed to preserve the identified sensitive lands and evaluate the potential to extend trail systems to and within the area.
5. Development shall mitigate the visibility of cuts and fills and buildings on hillsides that are visible from the viewing platforms identified in the ridgeline protection ordinance in Section 18.106.050. Mitigation shall include methods to conceal such cuts and fills and buildings, such as evergreen landscaping, hill terracing, use of earth-tone colors on structures, utilizing narrower street cross sections along steep slopes, moving streets, etc.

F. **Development Prohibited**. New subdivisions and new development shall avoid and preserve as undisturbed/natural open space the following areas:

1. *Steep slopes:* Identify areas with average slopes ranging from 10% to 20% and from 20% to 30%. Slopes over 30% are prohibited from development unless a lot has a contiguous building area that is a minimum of five thousand (5,000) square feet at or below thirty percent (30%) natural grade. All such lots shall include specific engineering designs to contain run off, erosion, and pollution on the subject property during construction and after construction. This includes the prevention of any materials caused by erosion flowing out onto adjacent trails, sidewalks and streets, adjacent fences and erosion onto the sensitive lands buffer areas. Cuts and fills shall be avoided in project design to the greatest extent possible and shall not exceed a 2 to 1 slope. Retaining walls extending over 6' in height shall include a landscaped terrace, a minimum of 4' in width for every 6' in height. Terraces maybe created at lesser heights to meet slope related issues, but the minimum number based on the 6' interval shall be maintained. Development in all steep sloped areas (20% and above) shall submit plans that conform to any City Standards, utilize Low Impact Development techniques, and specialized storm water permits such as SWPPP. Home development in the 20% to 30% slope category shall be limited to 1.5 stories. Revegetation with native plants of disturbed areas is required within 6 months for any grading performed for road work and after the occupancy of a home.
2. *Avalanche paths:* Such avalanche paths shall be identified, and development shall avoid such paths as recommended by a qualified Geotechnical Engineer.
3. *Fault lines, scarps, landslides, rock outcroppings, rock-fall, and mud/debris flow areas*: These topographical features shall be avoided and mitigated as recommended by a qualified Geotechnical Engineer. Determinations and mitigation techniques proposed that, when analyzed by the City Engineer, do not clearly resolve any identified issues may be subject to peer review at the City's discretion. The developer shall pay for such additional studies/peer reviews and the City shall manage the funds.
4. *Stream beds (including intermittent), gullies, ditches, flood channels, flood plains, areas of springs, seeps and surface water*: Pollution sources such as fuel tanks, septic tanks, shall be setback at least 100 feet from the pollution source to the hydrologic feature. Additional vegetation may be required between the hydrologic features and development for erosion control (with no fertilizer or pesticide use) or for public amenities. Hydrologic features that are accompanied by an amenity such as a park or trail shall include sufficient open area along and surrounding the hydrologic feature to ensure ample room to protect the feature and to provide area for enjoyment of the amenity; generally such buffering width should be an average of 50 feet.
5. *Canals.* Development shall avoid destabilizing the downhill portion of canals. No cuts shall be permitted below a 2:1 slope measured from the downhill bank of a canal without an engineered retaining wall. See graphic below "Canal Bank Stabilization".

Canal Bank Stabilization

Commented [JJ1]: Policy - is that an important item?



6. *Identified wetlands*: Identified wetlands shall be delineated using the Section 404 definition and procedures within the Clean Water Act. Protected wetlands shall be accompanied by additional open lands when they are adjacent or combined with usable open space and trails, with such adjacent areas averaging a width of 50 feet wide. Pollution sources such as fuel tanks, septic tanks, etc. shall be setback 100' from the pollution sources and identified wetlands. Additional vegetation may be required in these buffer areas for erosion control (with no fertilizer or pesticide use) or for public amenities.
7. *Wildfire Potential: Potential wildfire areas shall* be assessed, and mitigation strategies applied, as per 15.04.010 D.
8. *Culinary Water Source Protection. Public and private wells, and springs*: Such areas shall be identified within the subject property and on adjacent properties within 100'. City required notification processes shall be followed. Mitigation techniques shall follow the advisement of the source delineation report, current engineering practice, applicable state statutes, and contain all erosion and site pollution, within the development. See Wellhead Protection ordinance 8.28.
9. Development above ridgelines shall follow the standards in Chapter 18.106, Ridgeline Protection.
10. *View sheds:* Where new development is proposed along State roads, that lack adjacent scenic buffers, trail corridors or lack adjacent 10 acre or larger agricultural zoning, the view impacts shall be considered and buffered with additional landscaping, setbacks, and parallel trails defined as part of the site plan and/or preliminary subdivision plat.

G. **Development Constraints for Certain Sensitive Lands.** The following sensitive lands with potential hazards require additional mitigation techniques in new subdivisions and new development, and the developer shall provide mitigation for such hazards when they apply. The City requires a notice of such hazard and required mitigation to future property owners in a development agreement, on the subdivision plat and/or other device. Such additional mitigation techniques shall include, (practicable or available) but not be limited to the following:

1. Alluvial-fan-flood debris flow, collapsible soils, and shrink-swell soils. Mitigation techniques shall follow the advisement of a qualified Geotechnical Engineer and may be subject to peer review, at the developer's cost.
2. Shallow groundwater. As part of a geotechnical study, the depth of the water table shall be assessed in a year-long study or a March 15 to June 15 assessment if basements are to be utilized within the development or if groundwater is initially identified at depths less than 3 feet from the surface. If the water table is subject to area irrigation practices, the minimum time period for study is March 15 to August 15. During drought conditions, defined as 80% or below normal average precipitation, such studies shall provide an estimate of the rise in the water table if normal precipitation were to occur and at 110% of normal. If areas of shallow ground water are found that prohibit or impact foundations, such areas shall be noted in the concept design and carried forward on the preliminary and final plats. Possible mitigation techniques include the installation of a foundation drain (s) and sump pump (s), possible prohibition of basements, or other mitigation techniques as provided on the advisement of a qualified Geotechnical Engineer. Areas with ground water within 3' of the surface, shall require additional analysis to assess their feasibility for development.
3. 100-year flood zones. Mitigation techniques shall follow the procedures of Chapter 18.109, Flood Damage Prevention Ordinance.

H. **Acceptable Permanent Sensitive Land Preservation Instruments.** Such areas shall be preserved through a conservation easement, R lot designation, dedicated as accessible public open space to the City with a conservation easement, deed restricted with an HOA maintenance commitment, or other means that assure permanent preservation. Such areas shall include public access points, where trails are included in the preserved sensitive lands. Preservation techniques shall be negotiated as part of a development agreement.

I. **Sensitive Lands Preservation Incentives through Density Transfers**. Developers are encouraged not to build on slopes of 20 percent or greater. To this end, for slopes of 20 percent or greater, the applicant may ask the City to consider transfer of potential steeper area lots to other areas of the City or within the development, with a corresponding increase in density or to transfer, via a TDR-like mechanism, to identified receiving areas in the City consistent with the zone. Such transfers shall be implemented and established through negotiation with the City Council in a development agreement.

J. Developments including or adjacent to Sensitive Lands shall include restrictive covenants with mitigation techniques for the continued maintenance, preservation, and enhancement of Sensitive Lands and their associated open spaces.

K. **Other Considerations**.

1. **Buried wells, springs, and streams.** Existing development may have capped old wells and springs, piped streams, which could have potential cultural and historical value. If significant redevelopment of the site's structures, defined as over 50% of the building is being modified or replaced, efforts to re-establish an open stream or utilize the spring or well as a water feature, shall be considered in the design process. Buried/capped wells may be impractical to reestablish.

2. **Low Impact Development (LID) Storm Water Erosion and Pollution prevention techniques:** A LID Storm Water Report/Implementation techniques plan, to be prepared by a person or firm qualified by training and experience to have expert knowledge of the subject, shall be prepared according to State and City Standards and generally include the following:

    a. **An analysis,** including calculations and implementation rationale for possible LID Best Management Practices that could be implemented on the site:
        1) To improve the water quality and reduce the quantity of storm water generated from a development , on-site stormwater management shall meet or exceed approved City standards with encouragement to exceed standards.
        2) To provide methods of retention which would include water quality improvements, infiltration, evaporation, transpiration, rainwater harvesting and re-use, and as specified by City standards.
        3) For the preservation and enhancement of native vegetation in areas where storm water is being introduced. This shall be required as this vegetation retains, intercepts and transpires storm water, but may be modified as design considerations are considered.

3. **Heritage Trees**: Heritage Trees as designated by the Utah Heritage Tree Act and administered by the Utah Department of Natural Resources shall be preserved according to State Law**.**
4. **Species protection/animal migration areas:** Identify habitat areas (especially habitat for the sage grouse and endangered spotted frog) in the concept plan and in conjunction with other sensitive lands, consider preservation, with the understanding that with some areas such anticipated preservation may be impractical, based on the development design. Identified animal migration corridors may be replaced with a highly landscaped trail corridor (s).
5. **Development adjacent to agricultural lands** shall provide a recorded notification on the subdivision plat and/or other device, informing subsequent purchasers of the property of the potential for noise, odors and other characteristics involved in living adjacent to agricultural operations.