

MEMORANDUM

DATE: July 29, 2022

TO: Jared Morgan
GWC Capital
869 N 1500 W
Orem, UT 84057

FROM: Kayson Shurtz, P. E.
Hansen, Allen & Luce, Inc. (HAL)
859 W. South Jordan Pkwy. Ste. 200
South Jordan, UT 84095

SUBJECT: Springville City Annexation
Stormwater Drain System Review

PROJECT NO.: 344.224.200



INTRODUCTION

GWC Capital (GWC) requested that Hansen, Allen, & Luce, Inc. (HAL) evaluate storm drainage for a proposed 320-acre industrial development located near the intersection of 4000 S (Highway 77) and 800 W. The City requested that the scope of the study be augmented to include approximately 700 additional acres out to Springville City's Annexation Declaration Policy Boundary as shown in Figure 1. The additional developments are north of 4000 S between approximately 700 W and 800 W (160-acre parcel) and north of 4000 S between approximately 1300 W and 2000 W. All developments are bordered on the north by Provo Bay of Utah Lake. While it was necessary for the sewer, drinking water, and pressurized irrigation studies to also include a 477-acre area within City boundaries that was not included in the respective 2060 Master Plans, as it was expected to be built out past 2060, the 2014 Storm Drain Master Plan accounted for this area, so this area was not specifically included in this analysis.

As requested, HAL has performed a review of the effects that the proposed developments will have on the City's storm drain system. This includes a hydrologic modeling analysis of the proposed development.

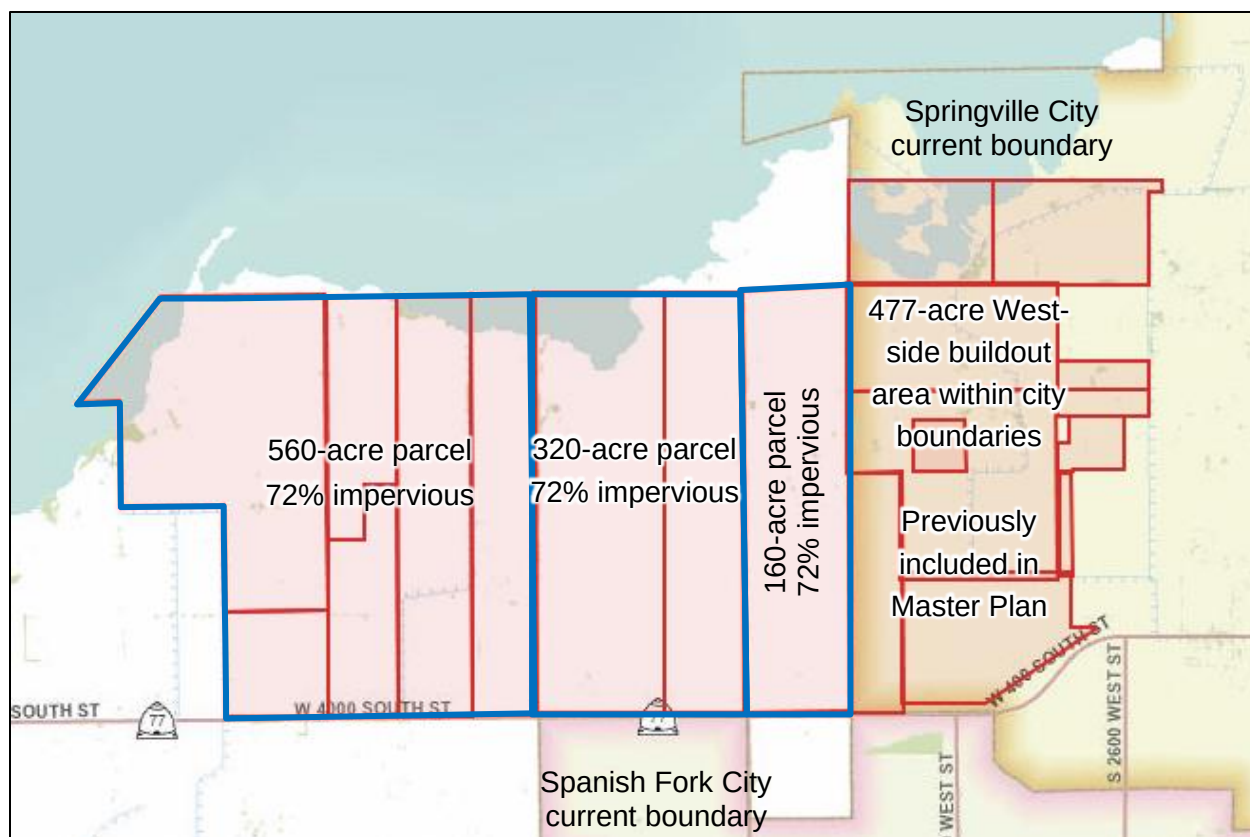


FIGURE 1: ANNEXATION STUDY BOUNDARY

STORMWATER DRAIN SYSTEM

The proposed developments border the current west boundary of Springville City. The development includes 3.6 million square feet of industrial warehouse on 320 acres and other unspecified industrial development on the remaining 720 acres.

New development in Spanish Fork City to the south, based on work previously completed by HAL (Appendix A), will convey two stormwater inputs across 4000 South at approximately 1600 West and 925 West (Spanish Fork City numbering). Spanish Fork City has sized these inputs based on the 100-year storm, which equates to 175 cfs at 1600 West and 127 cfs at 925 West (Appendix A, Figure 2). In general, Spanish Fork City chose a design level of 0.05 cfs/acre for the 25-year storm event for the area south of the annexation study. This stricter standard was chosen as roads were not effective enough to convey excess stormwater in a major event due to the relatively shallow slopes of the area. Similar conditions are expected for the annexation study area. This study also found that restricting flows to 0.05 cfs/acre instead of 0.15 cfs/acre only increased storage volume about 21%, and pipe sizes could then be typically two sizes smaller, which saves about 35% of pipe costs which more than offsets the cost of increased detention.

The 477-acre West-side buildout area within City boundaries was previously included in the Master Plan, which differs from the other feasibility analyses. It generally includes Master Plan subbasins LD-E-03, LD-E-02, LD-E-05, and LD-E-06 which will be served by two detention

facilities (0.6 AF and 2.1 AF) and a 30-inch and 48-inch line to drain into Dry Creek. This area is part of the Land Drain area from the Master Plan.

Highway 77 (4000 S) is a major street included in Mountainland Association of Governments (MAG) and Utah County transportation master plans, but there are no other major planned roads within the study area which would provide for utility access. MAG plans a new freeway which would cross the westernmost portion of the annexation study area.

Estimated Runoff Production

To estimate the magnitude of peak future flows and total runoff volume, the area which contributes runoff was delineated using ArcGIS. 0.5-meter LiDAR elevation flown in 2013-2014 was downloaded from UGRC Raster Data Discovery and was loaded into ArcGIS. ArcGIS was also used to fill sinks, run flow accumulation, and establish "pour points" (outlets). Basin delineation is shown in Figure 2. There were 11 subbasins with a range of 11.5-303 acres and an average area of 90.9 acres. This finding is consistent with the Master Plan observation that average subbasin size in the Land Drain area was close to 100 acres. These were named after the pattern of the Master Plan. The delineated areas totaled 1,000 acres out of 1,100 total, or about 91% of total land area. This assumption is more conservative than the assumption used in the drinking water analysis that 75% of land would be developable. Of the remaining 100 acres, about 35% is Provo Bay (i.e., below full lake elevation, 4989 feet) and the remaining 65% is expected to drain via sheet runoff into Utah Lake and not require master plan conveyance infrastructure.

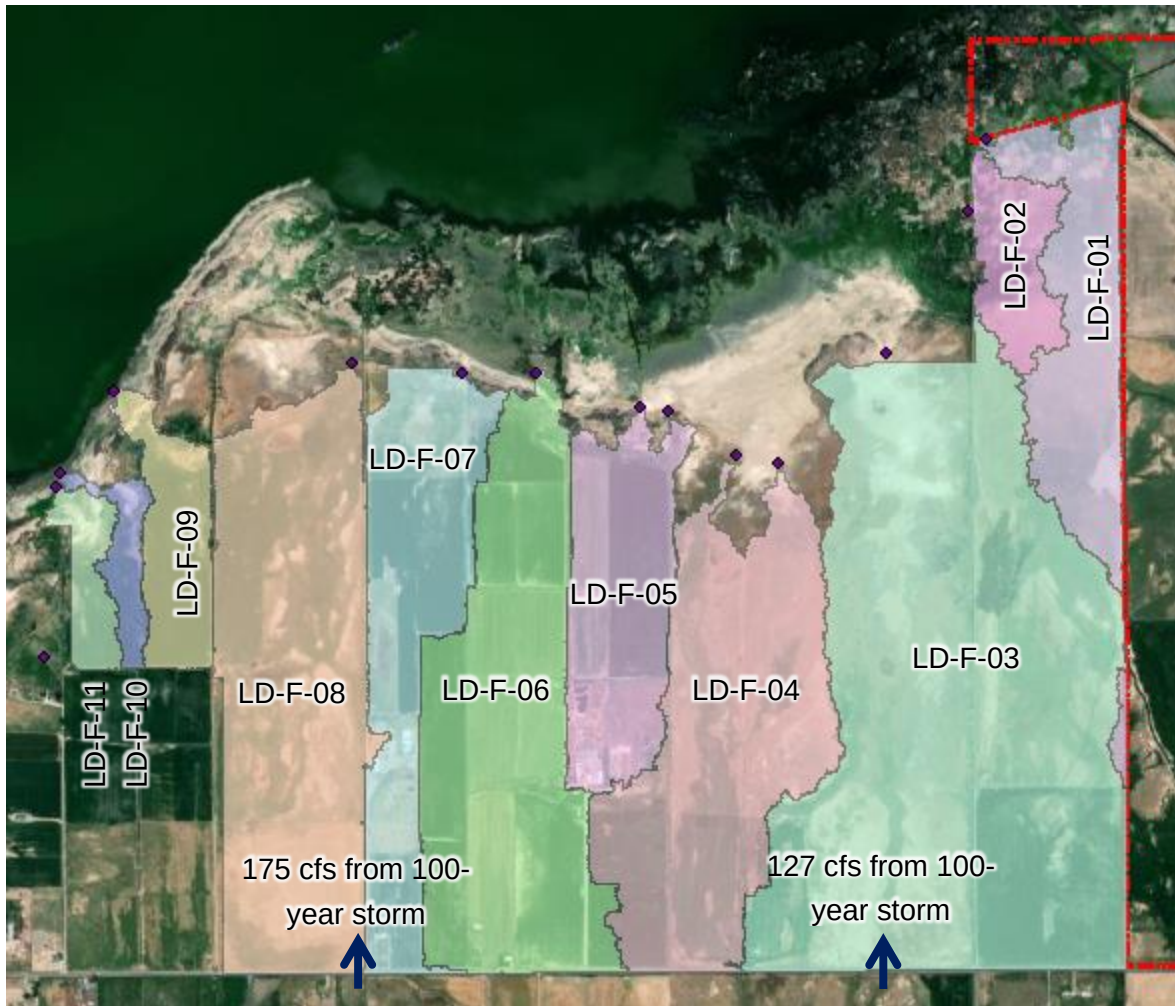


FIGURE 2: BASIN DELINEATION AND OUTLETS

The percent of existing directly connected impervious area (DCIA) was assumed to be 72% (a typical DCIA percentage for industrial developments). Curve number (CN) was assumed to remain the same after development with the only difference being the percent DCIA increased from 0 to 72. CNs for this area are very similar, ranging from 77 to 80, with the typical CN being about 79. This is based on about 94% of the soils being classified as soil type D (the remaining portion classified as soil type C or C/D) and an assumed pervious cover as defined by TR-55 of open space, good cover.

The longest flowpath and channel slope were used to estimate the time of concentration for each basin by the velocity upland method. Typical post-development velocities are expected to be around 2 fps.

The storm distribution selected by the City and used in this study is the modified 3-hour Farmer Fletcher, commonly known as the 3-hr Salt Lake County (SLCo) distribution. The design events evaluated as part of this study included the 25- and 100-year events. The SLCo distribution for the 25- and 100-year events can be seen below in Figure 3.

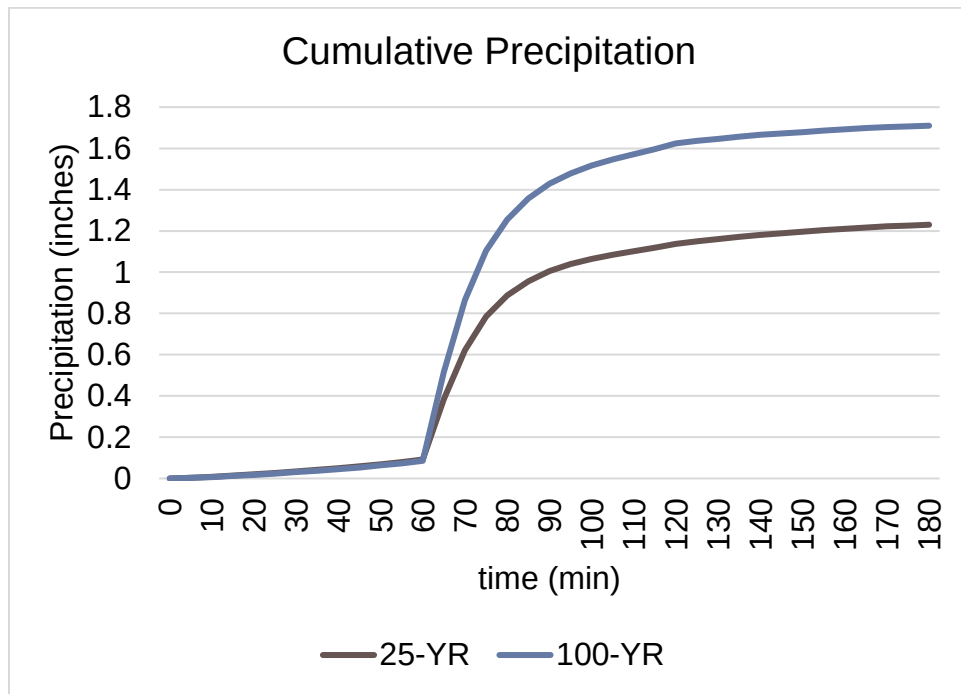


FIGURE 3: SALT LAKE COUNTY 3-HOUR CUMULATIVE DISTRIBUTION

The total rainfall depths as obtained from NOAA Atlas 14: Precipitation-Frequency Atlas of the United States (Bonnin et al. 2004; NOAA 2013) and can be seen below in Table 1. Using the study area of 1.56 square miles, a depth-area reduction factor (DARF) of 0.95 (Salt Lake City Cloudburst Study) was applied to the point precipitation estimates to obtain a more reasonable average precipitation depth for the area. When developments come in, they will be much smaller than the study area and should be designed to the point precipitation estimate and not use the area-adjusted rainfall depths.

TABLE 1: DESIGN RAINFALL DEPTHS

Design Storm	25-year	100-year
3-hour duration	1.29 in	1.80 in
With DARF	1.23 in	1.71 in

With development, peak flows approach 2 cfs/acre for the 25-year storm and 3 cfs/acre for the 100-year storm. Peak flows on a subbasin level are shown in Table 2.

TABLE 2: SUBBASIN PEAK RUNOFF AND STORAGE

Subbasin	Size (acres)	Composite Curve Number	Allowable 25-year basin runoff (cfs)	Uncontrolled 25-year Peak runoff (cfs)	Required Storage (AF)
LD-F-01	64	79.2	3.2	25.9	5.7
LD-F-02	25	79.3	1.3	23.3	
LD-F-03	303	89.0	15.1	153.5	19.8
LD-F-04	128	89.0	6.4	91.2	21.6
LD-F-05	62	80.0	3.1	59.2	
LD-F-06	134	80.0	6.7	80.7	
LD-F-07	82	80.0	4.1	48.9	14.7
LD-F-08	146	83.8	7.3	68.7	
LD-F-09	30	76.8	1.5	37.2	3.9
LD-F-10	12	78.7	0.6	16.9	
LD-F-11	14	77.7	0.7	27.9	
Total	1,000	N/A	50	633	65.7

25-year Storm Design

The design for the 25-year storm event was sized so that regional detention had a maximum release rate of about 0.05 cfs per acre. Pipes and channels were also sized to carry 0.05 cfs per acre. The proposed pipes and channels are shown in Figure 4.

The storage required to detain to a flow of 0.05 cfs for the 25-year storm is listed in Table 2. The average detention requirement is 0.066 AF/acre (2,870 ft³/acre) and only varied across the subbasins by about ±180 ft³/acre. It is recommended that the City require 1 foot of freeboard for all detention.

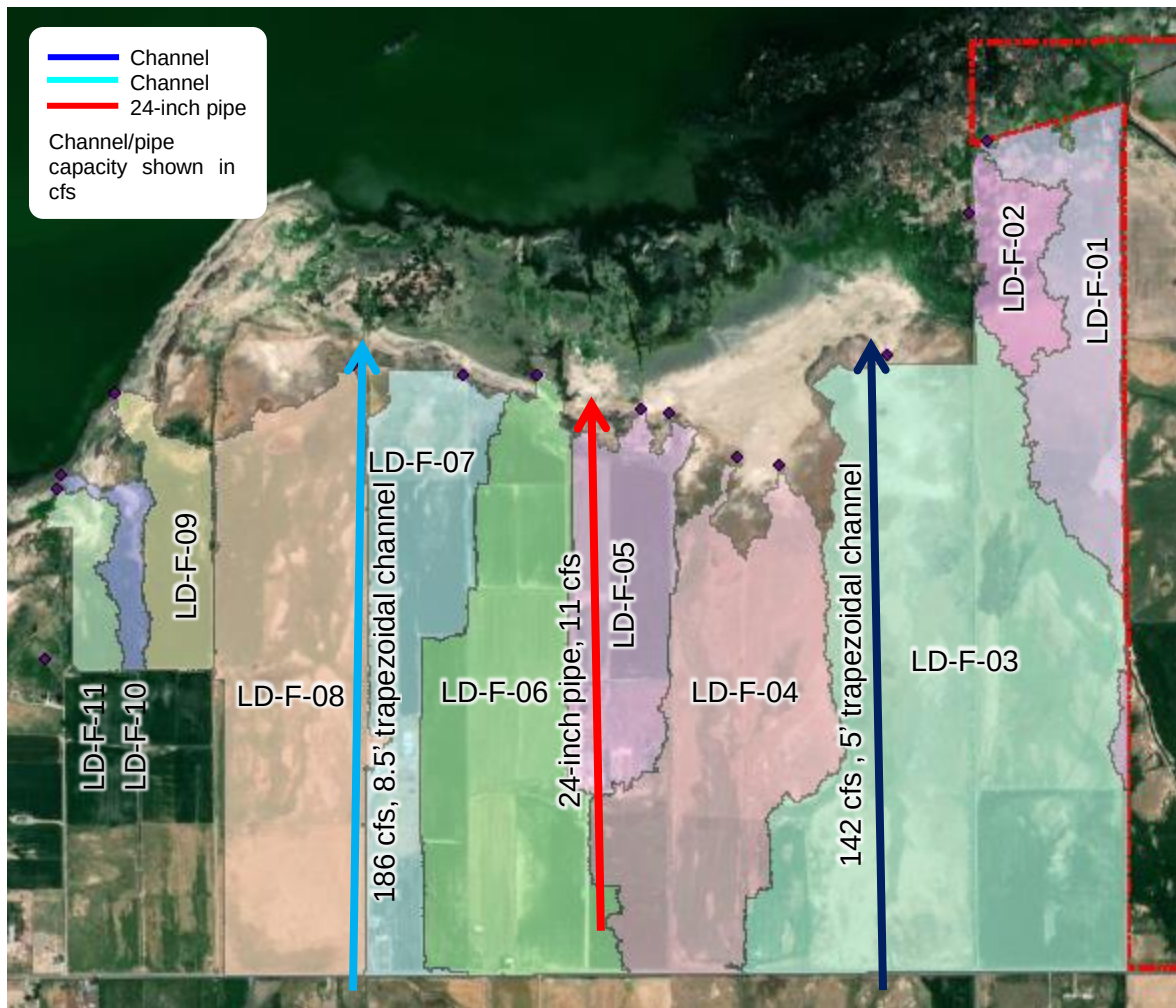


FIGURE 4: NEW STORMWATER CONVEYANCE

It is assumed that basins LD-F-01 and LD-F-02 will be difficult to develop due to wetlands, and that if they do, they will drain into Dry Creek to the east and Utah Lake to the north, so no Master Plan conveyance is planned for this area. Likewise, LD-F-09, LD-F-10, and LD-F-11 are small and would be expected to drain into Utah Lake. All basins would still be required to meet MS4 permit requirements including best management practices when possible.

The average slope for LD-F-03 is 0.3%. Therefore, a 5-foot (bottom width) trapezoidal channel with 3:1 side slopes (29-foot top width) could convey 142 cfs (the 100-year storm conveyance across 4000 South + the 25-year storm in subbasin) at a depth of 3.0 feet. It is recommended that these channels have 1 foot of freeboard.

The average slope for LD-F-07 and LD-F-08 is 0.3%. Therefore, an 8.5-foot (bottom width) trapezoidal channel with 3:1 side slopes (32.5-foot top width) could convey 186 cfs (the 100-year storm conveyance across 4000 South + the 25-year storm in subbasins) at a depth of 3.0 feet. It is recommended that these channels have 1 foot of freeboard.

The average slope for LD-F-04, LD-F-05, and LD-F-06 is 0.4%. Therefore, a 24-inch pipeline could convey 11.4 cfs (the 25-year storm in subbasins) at a depth of 1.4 feet.

100-year Storm on 25-year Infrastructure

When the 100-year storm was applied to the 25-year design with 1 foot of freeboard on all storage and conveyance (except pipe), all detention was overtopped but peak flows were limited compared to uncontrolled flows. Peak releases from overtopped detention were 0.17-0.26 cfs/acre.

The 5-foot channel has a maximum capacity of 271 cfs with freeboard. The maximum release from overtopped detention was 57 cfs. The combination of detained release and conveyed water south of 4000 South was 184 cfs, which is less than the maximum channel capacity.

The 8.5-foot channel has a maximum capacity of 344 cfs. The maximum release from overtopped detention was 46 cfs. The combination of detained release and conveyed water south of 4000 South was 221 cfs, which is less than the maximum channel capacity.

The 24-inch pipeline has a maximum capacity of 14.3 cfs. The maximum release from overtopped detention was 67 cfs, which is too large for the 24-inch line to carry. This line would need to be a 48-inch pipeline or a small channel, like a 1-foot (bottom width) trapezoidal channel with 3:1 side slopes (19 feet top width) at a depth of 3 feet.

100-year Storm Design

The design for the 100-year storm event was sized so that regional detention had a maximum release rate of 0.05 cfs per acre. Pipes and channels were also sized to carry 0.05 cfs per acre. The proposed pipes and channels are the same as the 25-year design and are shown in Figure 4. The same assumptions about LD-F-01, LD-F-02, LD-F-09, LD-F-10, and LD-F-11 are applied here as in the 25-year design.

The storage required to detain to a flow of 0.05 cfs for the 100-year storm is listed in Table 3. The average detention requirement is 0.10 AF/acre (4,360 ft³/acre) and only varied across the subbasins by about ±250 ft³/acre.

TABLE 3: SUBBASIN PEAK RUNOFF AND STORAGE

Subbasin	Size (acres)	Composite Curve Number	Allowable 100-year basin runoff (cfs)	Uncontrolled 100-year Peak runoff (cfs)	Required Storage (AF)
LD-F-01	64	79.2	3.2	38.4	8.4
LD-F-02	25	79.3	1.3	35.1	
LD-F-03	303	89.0	15.1	229	29.7
LD-F-04	128	89.0	6.4	137	32.6
LD-F-05	62	80.0	3.1	89.3	
LD-F-06	134	80.0	6.7	121	
LD-F-07	82	80.0	4.1	73.3	22.2
LD-F-08	146	83.8	7.3	102	
LD-F-09	30	76.8	1.5	55.8	5.7
LD-F-10	12	78.7	0.6	25.4	
LD-F-11	14	77.7	0.7	41.7	
Total	1,000	N/A	50	948	98.6

25- AND 100-YEAR FLOWS

Table 4 summarizes the expected 25- and 100-year flows contributed from Spanish Fork City to the annexation area, and from the annexation area.

TABLE 4: FLOWS (CFS) EXPECTED DURING 25- AND 100-YEAR EVENTS

Subbasin	8.5' channel		24" pipe		5' channel	
	25-year	100-year	25-year	100-year	25-year	100-year
Spanish Fork City	44	175	0	0	11	127
Annexation	11	46	16	67	15	57
Total	55	221	16	67	26	184

COST ESTIMATES

Channel cost estimates are based on the estimated cost of land acquisition and excavation. The pipe cost estimates assume an average of three feet depth to the crown of the pipe and one foot cover. These costs, shown in Table 5, are master planning level and it would be anticipated that the true costs could be $\pm 50\%$ from the numbers presented.

TABLE 5: COST ESTIMATES

Project	Cost
5-foot trapezoidal open channel -About 5,300 feet, land acquisition and excavation	\$1,100,000
8.5-foot trapezoidal open channel -About 5,300 feet, land acquisition and excavation	\$1,250,000
Construct 24" line to Provo Bay -About 5,300 feet out of street	\$1,040,000
Total	\$3,390,000

CONCLUSIONS AND RECOMMENDATIONS

- Due to the flat nature of the study area, it is recommended that the City use a more stringent detention standard of 0.05 cfs release for the 25-year storm. While a 100-year storm was investigated in this study, HAL recommends that the City require design to the 25-year storm with a foot of freeboard for channel conveyances and detention.
- The average storage requirement to achieve 0.05 cfs release for the 25-year storm in the study area is $2,870 \pm 180 \text{ ft}^3/\text{acre}$. It is recommended to require this detention of developers as they come in, and to require 1 foot of freeboard on detention facilities and channels.
- The 100-year storm on an area with 25-year storm infrastructure would overtop detention in all subbasins even with 1 foot of freeboard. Channel capacities would not be overwhelmed due to detention, but the 24" pipe would be overwhelmed.

Appendix A

MEMORANDUM

DATE: June 8, 2022

TO: Michael Clark
Assistant City Engineer
40 South Main St, Suite 240
Spanish Fork, UT 84660

FROM: Kayson Shurtz, P.E.
Daniel Jones, P.E., CFM
Hansen, Allen & Luce, Inc. (HAL)
859 West So. Jordan Pkwy – Suite 200
South Jordan, Utah 84095

SUBJECT: 2022 Storm Drain Master Planning Assistance

PROJECT NO.: 348.20.100



BACKGROUND

The City of Spanish Fork (City) requested assistance from Hansen, Allen, & Luce, Inc. (HAL) related to the J6 development and surrounding areas. Previous master plans had assumed this area would remain agricultural; however, in recent years that has changed; updated master planning solutions are needed in this area. This project's scope of work includes modeling development of a hydrologic model, evaluation of design flows and project alternatives to handle them, and workshops with the City to review the findings and solutions and select the preferred solution.

The study area is generally bounded on the north by 4000 South, on the east by 800 West, on the West by 1450 West, and on the south by 5950 South. It is expected that this area will completely develop into an industrial region, rather than an agricultural one. The City has asked that HAL provide them with the master plan sizing recommendations for conveyance and detention, with conveyance across 4000 South being designed to the 100-year flows.

HYDROLOGY

To estimate the magnitude of peak future flows and total runoff volume, the area which contributes runoff must be delineated. The US Army Corps of Engineers hydrology software HEC-HMS version 4.9 was used to do this. 0.5-meter LiDAR elevation flown in 2013-2014 was downloaded from UGRC Raster Data Discovery and was loaded into HMS. Sinks were filled, flow accumulation was run, and outlets were established. The percent of existing directly connected impervious area (DCIA) was assumed to be 0%

whereas the DCIA percent for the future case was assumed to be 72% (a typical DCIA percentage for industrial developments). The existing percent DCIA was assumed to be zero. Curve number was assumed to remain the same between existing and future with the only difference being the percent DCIA increased from 0 to 72. Curve numbers for this area range from the low 70s to 80, with the typical CN being about 78-79. This is based on about 90% of the soils being classified as soil type D (the remaining portion classified as soil type C) and an assumed pervious cover as defined by TR-55 of open space, good cover.

The longest flowpath and channel slope were used to estimate the time of concentration for each basin. In the existing case, a typical velocity is expected to be around 1.5 fps; for the future case, the typical velocities are expected to be around 5 fps.

The storm distribution selected by the City and used in this study is the modified 3-hour Farmer Fletcher, commonly known as the 3-hr Salt Lake County (SLCo) distribution. The design events evaluated as part of this study included the 10-, 25-, and 100-year events. The SLCo distribution for the 10- and 100-year events can be seen below in **Figure 1**.

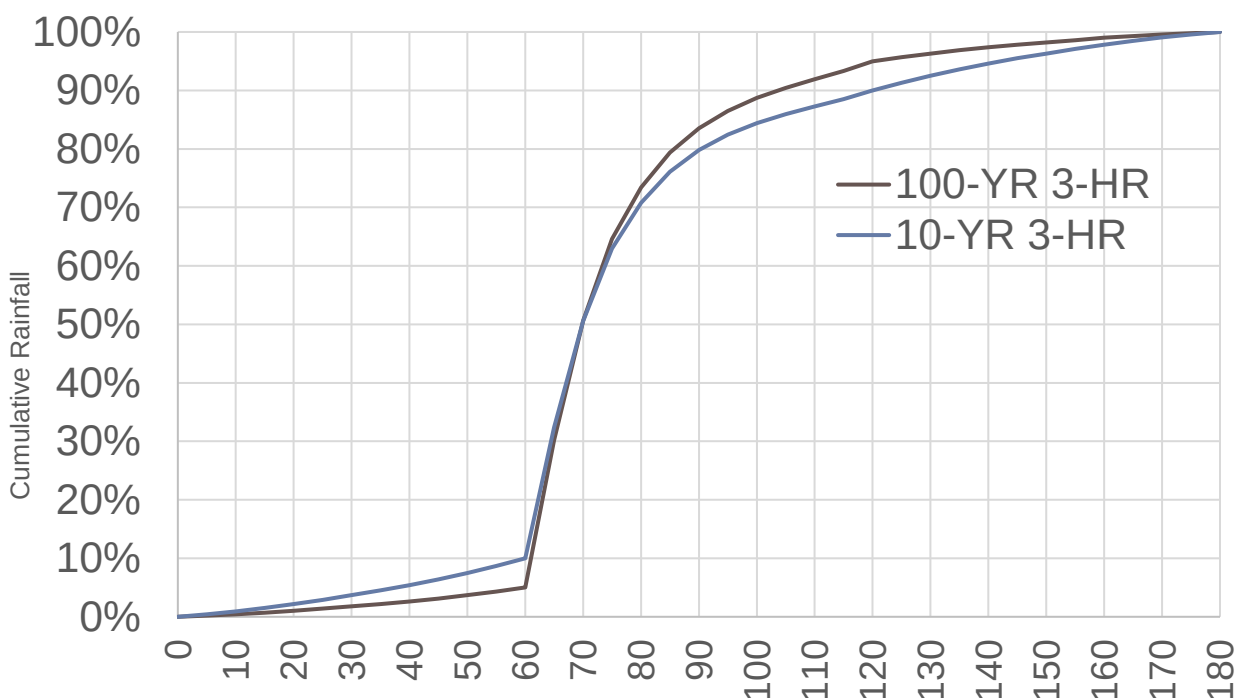


FIGURE 1. SALT LAKE COUNTY 3-HOUR UNITIZED DISTRIBUTION

The total rainfall depths as obtained from NOAA Atlas 14: Precipitation-Frequency Atlas of the United States (Bonnin et al. 2004; NOAA 2013) and can be seen below in **Table 1**. Using the study area of 2.17 square miles (5.62 km²), a depth-area reduction factor (DARF) of 0.925 (study completed for Walnut Gulch, AZ (Hydro-40)) was applied to the point precipitation estimates to obtain a more reasonable average precipitation depth for the area. When developments come in, they will be much smaller than the study area and

should be designed to the point precipitation estimate and not use the area-adjusted rainfall depths.

TABLE 1. DESIGN RAINFALL DEPTHS

Design Storm	10-year	25-year	100-year
3-hour duration	1.02	1.29	1.80
With DARF	0.94	1.19	1.67

For reference, existing peak flows approach 25 cfs for the 10-year storm (0.03 cfs/ac) and 210 cfs for the 100-year storm (0.15 cfs/ac). As mentioned above, future development will increase the impervious area, and therefore the runoff potential. This study evaluated various detention and release rate scenarios to determine the preferred alternative for this area.

COST AND PROTECTION EVALUATION

The potential detention release rate for this area which HAL evaluated were the 0.05 cfs/acre, 0.10 cfs/acre, and 0.15 cfs/acre. The greater the release rate, the greater the flows the pipes need to handle and the greater the pipe size. However, the more flow allowed to pass in the pipes, the required detention volume is reduced. An analysis was conducted to determine the most economic option for the desired level of protection.

The model was established so that runoff was stored in offline detention ponds with an orifice sized appropriately to contribute the design flowrate at a stage of three feet above the bottom of the pond. The pond volume was then expanded or reduced to get the design stage (and hence design flows) in the pipe. Once the design outflows were reached, the volume was recorded and a new basin model saved to evaluate the different design scenarios. The results of the analysis can be seen in **Table 2**.

TABLE 2. TOTAL STORAGE REQUIRED TO DETAIN TO DIFFERENT DESIGN RATES

Design Release Rate	Outlet Flows	Approximate Pipe Costs	Total Storage (acre-ft)		
			10-year	25-year	100-year
0.05 cfs/ac	70 cfs	\$10.3M	78.7	106.5	159.9
0.10 cfs/ac	140 cfs	\$13.9M	68.1	95.7	150.0
0.15 cfs/ac	210 cfs	\$15.9M	61.6	88.3	142.3

Note: Pipe costs assume "out of street" conditions with an additional 30% for engineering and contingency.

Corollaries of **Table 2** include:

1. It is more cost effective to install more detention than it is to upsize the pipe to handle the less-detained flows. Installing offline detention to reduce the design pipe flows only requires up to 28% more volume ($78.7/61.6 - 1$) whereas pipe costs are 53% greater ($15.9M/10.3M - 1$). This pattern follows for each return frequency.
2. Detention to a less frequent storm will increase the volume required and the protection offered.

PREFERRED ALTERNATIVE AND RESULTS SUMMARY

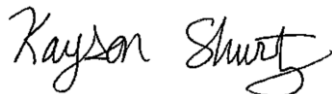
After discussion with the City, they selected the release rate of 0.05 cfs/ac up to the 25-year storm event. This is a stricter design level than for most of the City which is only required to detain to 0.15 cfs/ac for the 10-year and more frequent events. The reason the City has selected a more stringent criteria for this area is because the area is considerably flatter than most other parts of the City and this study identified concerns that if larger storms occurred, the roads in the area would be unable to convey the excess flows if the system were only designed to detain to the 10-year storm. Additionally, the soils are tight and have less ability to infiltrate excess water.

It is recommended that the City require 1 foot of freeboard for all detention and that, rather than the City build regional detention facilities prior to development, detention be required of development as it comes. The detention should be sized to include the runoff flows and volume from the roads. This will require additional inlets and piping that will be connected directly to each detention basin such that excess roadway drainage can be detained. These inlets and pipelines must be completely separate from the mainlines in the road to avoid storing the same water multiple times as it moves through the system. The 100-year design flow which the City requested for conveyance through 4000 South is 175 cfs through the northwestern corner and 127 cfs near the northeastern corner. These 100-year flows are large because they include all overflows not contained by the area's 25-year design and the high percent impervious that is anticipated in the area. The planimetric view of the planned conveyance lines with their sizes and capacities is shown in **Figure 2**.

The study area contains 1,449 acres of developable land, excluding master planned roads. Based on master planned roads, the lineal footage along future main roads in the area is 128,636 feet. While roads only account for 8.7 percent of the study area, they account for 14.6 percent of the total required detention volume ($15.5 \text{ AF} = 106.5 * 0.146$). Therefore, the City has elected to require an additional storage requirement per frontage length. The amount of detention per acre of development is 2,740 cubic feet ($91 \text{ AF} / 1449 \text{ acres}$) and the amount of detention per foot of frontage road is 5 cubic feet ($15.5 \text{ AF} / 128,636 \text{ ft}$).

Please feel free to contact me should you have any questions.

Sincerely,



Kayson Shurtz

Enclosures
HMS 4.9 Model

