City of Salmon, Stormwater Master Plan Phase 1

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Purpose

The purpose of this technical memorandum is to briefly describe the overall approach to stormwater master planning, report the results of Phase 1 of the City of Salmon Stormwater Master Plan, and provide recommendations for future phases of work to complete the master planning effort. Also included is a preliminary analysis of storm runoff for the Smedley Subdivision.

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Stormwater Master Planning

A stormwater master plan typically includes the following elements:

1. Watershed and sub-basin delineations
2. Data management protocol (GIS and database organization)
3. System mapping and inventory (pipes, streams, Best Management Practices-BMPs, etc.)
4. Existing and future system evaluation (hydrology and hydraulic analysis)
5. Capital Improvements Program (CIP) (list of projects, schedule, ranking, prioritization, and funding needs/strategy)
6. Implementation plan

The initial step in a stormwater master plan is to collect data which adequately describes both the hydrologic and hydraulic features of a stormwater system. Data is typically organized and mapped using GIS data management protocol. Watershed boundaries, sub-basins, and discharge points are delineated from existing topographic data. Larger watersheds are considered in rural areas, while smaller sub-basins are considered in urban areas. In the GIS environment, the watershed/sub-basin layer is intersected with land use, soils, zoning, and topography data to identify the hydrologic parameters used in calculating runoff. GIS tools are also used to create a geometric network consisting of stormwater conveyance features such as pipelines, canals, manholes, facilities, catchment inlets, etc. The geometric network is used to store the hydraulic parameters of the system (elevation, slope,

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pipe diameter, facility and catchment dimensions, etc.) and to ensure system connectivity. BMP's can also be mapped and cataloged in the GIS system for future evaluation.

The data collected in the initial phases of the stormwater master plan are used to model the hydrologic and hydraulic capacity of the stormwater system. The watershed/sub-basin boundaries and associated runoff parameters calculated from GIS data are used to model peak runoff and runoff hydrographs for a range of storm events including the 10-year, 25-year, and 100-year storm events. Each storm event is routed through the geometric network (inlets, pipelines, etc.) to determine the deficiencies in the system. Deficiencies are highlighted if surcharging occurs during a 10-year event and if manholes or inlets flood during a 25-year event. The 100-year storm event is modeled to determine the potential for property damage. The model incorporates both existing and future zoning and predicts the impact of future development on the stormwater system. Once deficiencies are identified, various scenarios for pipeline and facility improvements are modeled to identify the most appropriate corrections to existing and future deficiencies. The best alternatives are selected for pricing estimates. Based on the improvement scenarios and pricing estimates, capital improvement projects are selected and ranked in the Capital Improvement Program (CIP). Finally, funding and implementation strategies are considered.

A comprehensive stormwater master plan may also include some or all of the following components:

1. Environmental asset inventory by watershed (defines opportunities and constraints)
2. Stream assessments
3. Source evaluation in the watershed beyond the stream corridor and BMPs (land use, hot spots, problem areas, etc.)
4. Regulatory baseline (NPDES, FEMA, local stormwater permitting issues)
5. Specific problem area analysis (flooding, drainage, stream instability, water quality, etc.)
6. Demographics, socioeconomics, and public outreach strategy (crucial for project implementation)
7. Institutional analysis for program administration (agency inventory, responsibilities, and operations)
8. Monitoring and inspection protocols

City of Salmon Stormwater Master Plan, Phase 1 and Recommendations for Future Phases

The objective of Phase 1 of the City of Salmon Stormwater Master Plan was to begin the data collection process and prepare both the hydrologic and hydraulic GIS databases for use in future modeling. Based on the data provided by the City, CH2M HILL delineated watersheds/sub-basins and digitized the geometric network. Where available, attributes describing both the hydrologic and hydraulic components of the system have been added to the GIS database. The status of the data collection effort is discussed below and shown in

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Tables 1 and 2 for the hydrologic and hydraulic portions of the model respectively. Suggestions are given for future phases of work.

TABLE 1
HYDROLOGIC DATA

Data Requested	Purpose	Status
Elevation Data	Used to delineate watersheds and sub-basins. Also used for calculating Lag Time based on slope and length of each watershed and sub-basin.	DTM provided for area within City limits. 10 meter DEM downloaded from USGS website for area outside of City limits.
Location of major components of the stormwater system (inlets, pipelines, canals, facilities, detention basins, BMP's, etc.). Location of minor collection ditches not requested.		Data provided on hard copy maps for major components of the system including stormwater pipelines, inlet structures, detention basins, major canals, and BMP's.
Historic Rainfall Data (10-year, 25-year, and 100-year, 24 hour storm events)	Used to define design storm events and estimate runoff volume.	Total storm depth extracted from NOAA Atlas 2 precipitation maps.
Soils Data	Used to define hydrologic parameters for SCS Curve Number Runoff Method (Curve Number, Initial Abstraction, Percent Imperviousness, etc.)	Soil map unit names and hydrologic soil groups provided for 70% of area based on NRCS soils survey.
Existing and Future Zoning		Provided for existing City limits and Impact Area. Agricultural Land Use assumed outside of Impact Area.

As shown in Table 1, most of the hydrologic data is available for modeling analysis. Watershed and sub-basin delineation are shown in Figure 1 and Figure 2. The following items should be considered in a future phase of work to complete the hydrologic dataset:

1. Sub-basin delineation should be confirmed with a site visit. This is of particular concern in new areas of town such as the Smedley Subdivision where new construction may divert flow in a different direction than natural drainage patterns indicate.

2. Soils data for thirty percent of the watershed areas considered in the system are unavailable. The existing soils data will need to be extrapolated to areas of missing data (see Figure 3).

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3. Land Use/Zoning outside of the City Impact Area is assumed to be "Agricultural." This assumption should be reviewed and confirmed (see Figure 4).

4. Land use and soils data should be used to define hydrologic parameters for each watershed and sub-basin. Parameters include SCS Curve Number, percent imperviousness, and initial abstraction.

TABLE 2
HYDRAULIC DATA

Data Requested/Attributes	Purpose	Status
Open channels (canals and ditches)		
bottom width	Used to model channel capacity.	Location for main canals provided. Other attribute data not provided.
full bank height		
full bank width		
surface description		
flow line elevation		
Piping		
material	Used to model pipeline capacity.	Location and diameter of pipelines provided. Invert elevation and material not provided.
diameter		
invert elevation		
Manholes/Inlets		
size/dimensions	Used to model surcharge and flooding in stormwater pipeline system.	Location provided. Other attribute data not provided.
invert elevation		
rim elevation		
Detention Facilities/BMPs		
type	Used to model facilitiy capacity.	Location and description provided. Other attributes not provided.
description		
size and dimensions		
elevations (where applicable)		

As shown in Table 2 and Figure 2, the locations for many of the components of the stormwater system have been provided and incorporated into the GIS geometric network; however, many of the hydraulic attributes required for modeling system capacity are missing. A field survey will be required to provide the missing attributes including invert and rim elevations for all pipelines/manholes, canal dimensions and elevations, and facility dimensions. The field survey and the integration of the field data into GIS are recommended

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as the next steps in the stormwater master planning process. The field survey should be considered for Spring 2007 to keep the plan progressing.

Example Modeling Results – Smedley Subdivision

Phase 1 funding for the Salmon Stormwater Plan allowed for some preliminary hydrologic modeling in the Smedley Subdivision. Since the construction of the Smedley Subdivision, flooding has been reported at the intersection of Syringa Drive and Fulton Street during storm events (see Figure 5). In the recent past, flooding has caused some road damage in this area. Based on general observation from the City, as much as 90% of runoff from the Smedley Subdivision attempts to enter the 18-inch stormwater pipeline at this intersection.

The hydrologic modeling approach for Smedley Subdivision will be described below and is similar to the city wide approach recommended in future phases of work. The modeling results are preliminary for several reasons listed below and should be verified during future phases of work:

1. Sub-basin delineation in the Smedley Subdivision should be confirmed with a site visit. For this modeling exercise, peak flows are likely overestimated because 90% of runoff is assumed to be diverted from natural drainage paths to the 18-inch pipeline on Fulton Street.

2. Pipeline and manhole invert and rim elevations are unknown for the Fulton St. pipeline. For this modeling exercise, the pipeline slope is assumed to be equal to the ground slope which has been derived from available digital data. Pipeline full capacity is compared to peak storm flows based on the estimated slope. Storage capacity in manholes is not considered.

   To adequately determine the available capacity of the system, slopes should instead be determined from surveyed invert elevations. Manhole invert and rim elevations based on surveyed data should be modeled to determine the system potential for storage, surcharge, and flooding.

<u>Hydrology</u>

All hydrologic modeling was performed in HEC-HMS using the Soil Conservation Service (SCS) Curve Number Method. The SCS Curve Number method incorporates soil type and land use data to determine three parameters (curve number, initial abstraction, and percent imperviousness). These parameters are combined with sub-basin areas to calculate runoff. Seven sub-basins were modeled in the Smedley Subdivision area. Because soils and land use data are more refined than the seven sub-basin areas, composite numbers for each parameter were calculated based on area weighting. Additionally, HEC-HMS requires lag times for each sub-basin to determine the amount of time required for precipitation to travel from the furthest distance in the sub-basin to the outlet point. Lag times were calculated for each sub-basin using the TR-55 methodology for shallow concentrated flow. Parameters for each sub-basin are shown in Table 3 (see Figure 5 for sub-basin labeling). Runoff was calculated for each storm event using NOAA Atlas 2 precipitation maps for total storm

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depth and distributed over 24 hours using the SCS Type II distribution. Total storm depths were 1.6 inches, 1.8 inches, and 2.2 inches for the 10-year, 25-year, and 100-year storm events respectively.

TABLE 3
HYDROLOGY DATA SMEDLEY SUBDIVISION

Sub-Basin ID	Area (sqmi)	CN	Percent Imperviousness	Initial Abstraction (in)	Lag Time (min)	Hydrologic Soils Group	Zoning
1	0.02	77	43	0.3	4	B	residential, medium density, paved roads
2	0.09	70	26	0.4	12	B and C	residential, low to medium density, paved roads
3	0.04	75	36	0.4	12	B and C	residential, medium density, paved roads
4	0.01	83	53	0.3	1	B and C	residential, medium density, paved roads
5	0.01	81	43	0.4	3	B and C	residential, medium density, paved roads
6	0.11	73	30	0.4	26	B and C	residential, low to medium density, paved roads
7	0.50	80	34	0.3	25	B, C, and D	residential, low to medium density and agricultural, paved roads

Hydraulics

As stated previously, the hydraulic portion of the model was not completely modeled for storage, surcharge, and flooding. Peak flows from the hydrologic portion of the model were compared to pipe full flows to estimate the extent of the deficiency in the 18-inch pipeline on Fulton St. Pipeline capacity was calculated using Manning's Equation with a roughness coefficient of 0.013. The pipeline slope was assumed to be equal to the maximum ground slope which was derived from available digital data (0.05 ft/ft).

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Results

The preliminary results indicate that the 18-inch pipeline is significantly undersized to handle any of the design storm events including the 10-year event. Table 4a lists the full flow capacity and peak flows expected for each of the three storm events.

TABLE 4A
SMEDLEY SUBDIVISION PRELIMINARY RESULTS

Scenario	Flow (cfs)
18-inch Pipeline Full Capacity	24
10-Year Peak Flow at Syringa Dr and Fulton St	266
25-Year Peak Flow at Syringa Dr and Fulton St	315
100-Year Peak Flow at Syringa Dr and Fulton St	421

Because peak flows are greater than ten times the full flow capacity of the pipe, the model was run again eliminating the western most and largest sub-basin (number 7). This was an attempt to determine the peak flows if the largest sub-basin flows are diverted away from the 18-inch pipeline. The second set of model results are shown in Table 4b and indicate that the 18-inch pipeline is still undersized.

TABLE 4B
SMEDLEY SUBDIVISION PRELIMINARY RESULTS WITH SUB-BASIN 7 DIVERTED

Scenario	Flow (cfs)
10-Year Peak Flow at Syringa Dr and Fulton St with Sub-Basin 7 Flows Diverted	57
25-Year Peak Flow at Syringa Dr and Fulton St with Sub-Basin 7 Flows Diverted	68
100-Year Peak Flow at Syringa Dr and Fulton St with Sub-Basin 7 Flows Diverted	91

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Conclusions

The analysis results indicate that the 18-inch pipeline on Fulton St. is significantly undersized. Because some of the model sub-basins enter the system upstream of the Fulton St/Syringa Dr intersection, it is likely that upstream pipelines of 8-inch, 10-inch, and 12-inch diameters are also undersized. The preliminary flows calculated in the model should not be used to design improvements. The following tasks should be performed to finalize the flow numbers for improvement analysis:

1. A site visit to confirm sub-basin delineation and outlet points. The site visit should focus on determining where Smedley Subdivision runoff enters the Fulton St. stormwater pipeline and where runoff follows natural flow paths elsewhere.

2. Additional hydraulic data collection and implementation into the model. With additional hydraulic data available, system capacity, storage, and surcharge can be modeled.

Because of recent flooding and road damage, the City of Salmon may want to consider further analysis and improvement to the Fulton Street area prior to the completion of future phases of the master plan.

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