Appendix B

Data Compiled for Use in Model Development

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Appendix - B Data Compiled for Use in Model Development

B.1 Background Data

Data requested from the City of Richland for use in this study is summarized in **Figure B-1**. The South Richland Sewer Review (SRSR) project memo is also included.

Figure B-1 – Background Data Sources

Item Requested	City Contact Person	Date Received	Comments	Status
GIS Basemap Data				
Sewer Collection System	GIS	May 2013	Manholes, gravity lines, force mains, lift stations, etc.	Completed
Parcels	GIS	May 2013		Completed
Roads	GIS	May 2013		Completed
City Limits	GIS	May 2013		Completed
Zoning	GIS	May 2013		Completed
Assessor Data	GIS	--	Including land use characteristics such as what type of residential (single family or apartment), number of apartment units, what type of commercial (restaurant, retail, office, hotel, etc)	Not used
Impact Area	GIS	May 2013		Completed
Comprehensive Plan	GIS	May 2013		Completed
Subdivisions	GIS	--	If available	Not used
Contours	GIS	--	Better than USGS if available	Not used
Imagery	GIS	--	If available	Not used

Item Requested	City Contact Person	Date Received	Comments	Status
Treatment Plant Flows				
Avg Day Flows	John Bykonen	5/13/2014	Monthly influent data from July 1, 2013 to Jan 1, 2014; clarify location of monitor # FIT0005.	Completed
Peak Day Flows	John Bykonen	5/13/2014	Monthly influent data July 1, 2013 to Jan 1, 2014.	Completed
Avg Hour Flows	John Bykonen	5/13/2014	Daily influent data from July 1, 2013 to Jan 1, 2014.	Completed
Peak Hour Flows	John Bykonen	5/13/2014	Daily influent data from July 1, 2013 to Jan 1, 2014.	Completed
Influent Sampling Data	John Bykonen	5/15/2014	All influent sampling data as available; e.g. BOD, TSS, nitrogen (total and ammonia), phosphorus, temperature	Completed
Lift Station Flows (Each Lift Station)				
Lift Stations	Vern McGraw	Date Not Recorded	Update Lift Station Capacity Spreadsheet	Completed
Avg Hour Flows	Vern McGraw	Date Not Recorded	Daily data for last 1 year: (Apr 2013- Mar 31, 2014), if available	Completed
Peak Hour Flows	Vern McGraw	Date Not Recorded	Daily data for last 1 year: (Apr 2013- Mar 31, 2014), if available	Completed
Record Drawings / Design Information	Vern McGraw	Date Not Recorded	Available record drawings, design memoranda, pump operating data (e.g. pump curves).	Completed
Permitted / Industrial Flows (if applicable)				
Avg Hour Flows	Toby	5/14/2014	Daily data for last 3 years	Completed

Item Requested	City Contact Person	Date Received	Comments	Status
Peak Hour Flows	Toby	5/14/2014	Daily data for last 3 years	Completed
Houly Flows	Toby	5/14/2014	Hourly flows for 4 weeks; including the period when flow monitoring is completed.	Completed
Permitted Flows	Toby	5/14/2014	Permit limits (to determine committed flows) and annual reports	Completed
Water Meters				
GIS shapefile	GIS	May 2013	Location with address and Water Meter ID (ID corresponding to billing)	Completed
Usage Data	Shari	Oct 2013	Data for winter use (Nov 2012, Dec 2012, Jan 2013, Feb 2013)..	Completed
Other Data				
Rainfall Data		N/A	Data for last 3 years from the WWTP.	Not used
Pipe Condition Data		N/A	Age, material, condition, etc.	Not used
Development plans and preliminary plats for developments in the study area	Jay	Dec 2013	Are preliminary plans available at this time? Any redevelopment plans?	Completed

City Of Richland Sewer Lift Station Wetwell Capacities

Modified 9/24/13 w/phone call w/Vern

Lift Station Identification	Wetwell Diameter	Storage Area	Wetwell Capacity	Pump Off	Pump On	Pump Range	Pumped Capacity	
	Feet	Inches	Gallons	Inches	Inches	Inches	Gallons	
Battelle	12	80	5637	25	75	50	3523	
Bellerive	6	74	1304	15	72	57	1004	6 starts per 2 hours
Bradley	10	58	2838	20	50	30	1468	
Broadmoor	6	27	476	?	?	#VALUE!	#VALUE!	
Columbia Point	10	80	3915	25	75	50	2447	
Duportail	6	72	1268	45	70	25	440	
Fowler	6	100	1762	40	95	55	969	
Meadow Ridge	6	70	1233	15	50	35	617	Vern will call back
Meadows South	7	42	1007	30	60	30	719	4 starts per 2 hours
Mental Health	6	55	969	24	55	31	546	
Montana Street	8	70	2192	50	80	30	939	22 starts per 2 hours
Tapteal	4	51	399	?	?	#VALUE!	#VALUE!	
Terminal Drive	8	38.5	1206	?	?	#VALUE!	#VALUE!	
Waterfront	6	45	793	18	36	18	317	
WellhouseLoop	6	31	546	?	?	#VALUE!	#VALUE!	
Willowbrook	6	79	1392	40	63	23	405	

J-U-B ENGINEERS, INC.

J-U-B COMPANIES | THE LANGDON GROUP | GATEWAY MAPPING INC.

MEMORANDUM

DATE: April 30th 2014

TO: Jay Marlow, P.E., Public Works Capital Projects Manager

CC: Pete Rogalsky, P.E., Public Works Director

FROM: Zachary Wright, P.E., Project Engineer
Alex Fazzari, P.E., Project Manager

SUBJECT: South Richland Sewer Review

The purpose of this technical memo is to briefly review the previous sewer planning studies that have been prepared for the South Richland area, to present sewer hydraulic modeling results completed for planned development within the Study Area and to present master plan alternatives to aid the City of Richland (City) with identifying Capital Improvement Plans (CIP) within the Study Area. A background review will summarize the independent evaluations completed and highlight their recommendations. Following the background review, a description of the sewer hydraulic modeling completed for this area will identify the available capacity of the existing collection system and highlight suggested improvements. The memo will conclude with a discussion of several improvement alternatives, their impacts, and their estimated construction and life cycle costs.

SOUTH RICHLAND SEWER BACKGROUND

The Badger Mountain development is the source of the majority of the sanitary sewer flow in the study area as shown in Figure 1. Several sewer planning efforts have been undertaken over the past 15 years. The following is a brief summary of studies completed in 2001, 2004, 2006, and 2010 for the Badger Mountain development.

2001 Feasibility Study for Wastewater Facilities

This study prepared by J-U-B looked at the planning level feasibility for providing sanitary sewer service to the proposed Badger Mountain Project. In 2001, a lower density of residential development was planned and included a golf course as part of the development. The Study evaluated several different wastewater treatment and disposal options including: onsite sewer systems, evaporation ponds, lagoons, and conventional activated sludge plant. The Study also evaluated connection to the City of Richland sanitary sewer collection system by connecting to an interceptor planned to be extended south from Meadow Springs approximately 2 miles east

of the project site (Leslie interceptor). The Study identified three feasible ways to connect to this future sewer trunk:

1. Rachel Road: A lift station would pump sewage via a force main along Clover Road to the top of Rachel Road and then a gravity collection system would follow Rachel Road. A significant amount of pavement restoration, traffic control, and construction impacts to residences were noted as key issues.
2. Canyon Route: A lift station could be avoided if a gravity sewer interceptor was constructed through the canyon that passes through the El Rancho Reata development to Leslie Road. The presence of shallow bedrock was identified as a key issue that would require further evaluation.
3. Bermuda/Reata Road: A lift station would be required to pump sewage to the high point near the Bermuda/Reata Road intersection. The alignment would follow Reata Road east to Leslie Road and then north to Rachel/Leslie Road intersection. The route is not very direct and pavement restoration, traffic control, and construction impacts to residents were identified as key issues.

An alternative point of connection to the Richland sewer system was also identified as the interceptor on Gage Boulevard. This fourth option would follow the alignment of a new road planned to be constructed from Gage Boulevard southwest over the ridge to the Badger Mountain development. A lift station would still be required; however, the pavement restoration, traffic control, and disruption to residences would be minimized.

Because the study area was not part of the City's UGA at the time, the connections to the City system were dropped from further consideration. However, it was noted that connection to a municipal system was the least costly option and the development was encouraged to continue to pursue the possibility of annexing the area in to the City UGA.

2004 General Sewer Plan

The General Sewer Plan update prepared by Brown & Caldwell evaluated four alternative locations for routing flows from the planned Badger Mountain development into the City's collection system. The planning level flows for the development at the time amounted to a total average daily flow of approximately 1.5 million gallons per day (mgd). The four collection system alternatives evaluated were:

1. Willowbrook Basin: This was essentially the Rachel Road alternative that was identified in the J-U-B Study. A lift station would pump flows through a force main along Clover Road and then gravity flow through an interceptor along Rachel Road. Several existing pipes were identified as needing to be upsized for this alternative.
2. West Gage Basin: This was essentially the fourth alternative identified in the J-U-B Study. A new lift station would pump flows over the ridge to the north of the Badger

Mountain development and into the trunk on Gage Boulevard. Several existing pipes were identified as needing to be upsized for this alternative.

3. Dallas Road: This alternative considered a lift station that would pump flows around Badger Mountain to the northwest and connect to the City's system in the Country Estates development. Several existing pipes were identified as needing to be upsized for this alternative.
4. Reata Road: This was essentially the third alternative identified in the J-U-B Study. This alternative considered a lift station that would pump flows south and east along Reata Road and connect to the future Bellerive Lift Station. Several existing pipes were identified as needing to be upsized for this alternative.

The General Sewer Plan provided planning level cost estimates and identified the Dallas Road alternative as the least costly alternative. However, it was noted that the City would be required to correct several existing system deficiencies and this option increases the City's operations and maintenance costs – which were not accounted for in the analysis. The General Sewer Plan also evaluated a fifth alternative – a satellite Membrane Bioreactor (MBR) Reclamation plant. This alternative would provide a remote, modular wastewater treatment plant that would provide highly treated water for reuse. It was identified that a use, such as a golf course or playfields, would need to be found for the reuse water in order for this option to be feasible. In addition, further evaluation would need to account for energy, O & M costs, and effluent disposal.

<u>2006 Badger Mountain/Valley View UGA Expansion Capital Facilities Plan</u>

This study prepared by J-U-B looked at capital facilities impacts of expanding the City of Richland UGA boundary to incorporate the proposed Badger Mountain development area. The plan identified two distinct drainage basins in the planning area – the West Basin and the East Basin and identified that a lift station would be needed for each drainage basin. The sanitary sewer plan identified sewer flows from the West Basin that would be pumped northwest through the Country Heights development (alternative 3 identified in the 2004 General Sewer Plan). The East Basin would be pumped via a lift station over the ridge to the north to Meadow Hills Drive and into the interceptor on Gage Boulevard (alternative 2 from the 2004 General Sewer Plan).

<u>2010 Badger Mountain Sub-Area Plan</u>

This study prepared by PacWest Engineering developed the master plan for the Badger Mountain development which had become part of the City's UGA at that time. The Plan evaluated three alternatives:

1. West Basin to Country Ridge, East Basin and Wilson Basin to Meadow Hills.
2. West Basin, East Basin, and Wilson Basin all to Meadow Hills.

3. West Basin and East Basin to Country Ridge, and Wilson Basin to Meadow Hills.

Preliminary cost estimates indicated that option 3 was the least cost alternative. However, the costs did not take into the account the relatively high operations and maintenance costs that would be incurred by the City to operate two new, large, regional lift stations. Moreover, the cost estimates for the lift stations also appear to be low.

In the time since the Sub-Area Plan, the Leslie Interceptor was constructed in 2011. Its construction makes routing flows to the east much more feasible. Currently the City and the developer are exploring alternatives that involve routing some sewer flows to this pipe. Thus, the impetus for this South Sewer Study was to evaluate the feasibility of routing Badger South sewer flows to the Leslie Interceptor and to evaluate alternative facilities to accomplish that.

SOUTH RICHLAND SEWER PLANNING & MODEL DEVELOPMENT

Model Development

For this planning and modeling effort, the Study Area consists of two separate locations, the first being the proposed annexation area, approximately 130 acres bounded on the south by Interstate 82 and on the north by Reata Road, and the second being the East Badger South development. These areas are shown on Figure 1 in the Appendix. Development in both areas will require new sewer infrastructure that will connect to the Leslie Interceptor and drain to the Bellerive Lift Station.

To analyze the impacts of the Study Area on the City's existing sewer collection system (south of the Yakima River), the system layer and flow layer for the existing hydraulic model were updated. The update to the system layer included adding all trunk pipes (10 inches and larger) constructed since 2004 to the model by use of record drawings and GIS info provided by the City. The model was then checked for errors, including locations of reverse pipe grade or a decrease in pipe diameter. These instances were identified in a map book and sent to the City for corrections. Once the corrections were made, the system layer update was complete. The update to the flow layer involved using City water meter data from November 2012 to March 2013 and equating these winter water use flows to sewer flows for existing users. To predict flows for developed areas, unit flows for each land use type were calculated from the water meter data. These values are included in Table 1.

TABLE 1 – UNIT FLOWS BASED ON LAND USE

Land Use	GPAD[1]	GPDU[2]
Assisted Living	3,300	
Car Wash	7,900	
Church	150	
Commercial	350	
Hospital	5,500	
Hotel	3,000	
Industrial	180	
Office	350	
Open Space	10	
Public	540	
Residential-High		147.0
Residential-Low		160.0
Residential-Medium		147.0
Restaurant	2,500	
RV Park	800	
School	170	

[1] GPAD = Gallons per acre per day
[2] GPDU = Gallons per dwelling unit

With updated system and flow layers, the hydraulic model was then calibrated for dry weather flow. This was accomplished by comparing the predicted flows generated by the model to the data collected from the two flow monitoring locations provided by the City. Adjustments to the residential diurnal patterns used in the model as well as the amount of infiltration assumed reduced the percent difference between the model flows and the observed flows to less than 5%. System infiltration was identified as the amount of flow remaining in the collection system during overnight hours (2 am – 4 am). Infiltration was considered higher in areas near the intersection of Gage and Leslie and in the Montana lift station basin.

At this point the final model adjustment was made to account for wet weather inflow. Typically flow monitoring will collect data from an extended range of time and include a wet weather event; however no wet weather event occurred during the flow monitoring phase of this study. Therefore a local 24 hour storm event, SCS Type II, with a 2-year recurrence level was used and the peak runoff flow was aligned with the sanitary peak flow for both weekday and weekend diurnal curves. Previous sewer modeling projects have shown that this method will yield a

reasonable wet weather sewer event. Comparing the wet weather flows to the dry weather flows, the peak flow increased approximately 20%.

Using wet weather flows and the updated hydraulic model, four scenarios were created to analyze the impact of development on the existing collection system. The scenarios are listed with a brief description:

1. Existing System – Present day analysis of the existing collection system for the City south of the Yakima River.
2. Infill Area – The complete development of currently undeveloped areas, as shown on Figure 2 included in the Appendix.
3. Annexation Area – Addition of the annexation area (as shown on Figure 1) to Scenario #2.
4. Badger South Area – Addition of the East Badger South development (as shown on Figure 1) to Scenario #3.

Modeling Results & Master Planning

The impacts of each scenario on the existing collection system were identified on figures showing the ratio of peak daily flow depth divided by pipe diameter (d/D). Table 2 lists each scenario and the notable impacts observed. Figures 2, 3, and 4 identify the results for Scenarios 2, 3, and 4, respectively.

TABLE 2 – EXISTING COLLECTION SYSTEM IMPACTS

#	Scenario	Notable Impacts
1	Existing System	• None Observed. Peak flows to Bellerive lift station are 100 gpm.
2	Infill Area	• Flows entering the Bellerive lift station increase to 450 gpm, which would require an increase of the current pumping capacity (300 gpm). • Assuming a pumping rate of 600 gpm for the Bellerive lift station, the downstream impacts result in surcharging of the existing 8-inch collection system (pipes and manholes)[1]
3	Annexation Area	• Flows entering the Bellerive Lift Station increase to 515 gpm • Downstream surcharging increases
4	Badger South Area	• d/D for the existing Leslie Interceptor is between 0.75 to 1.0 • Downstream surcharging increases

[1] The existing 300 gpm capacity Bellerive lift station could be rehabilitated to a 600 gpm capacity facility given the size of the existing wet well and force main.

During the Master Plan meeting each scenario was discussed with the City and its impacts were noted. Additionally, the land-use assumptions for several large areas draining to the Bellerive

Lift Station were clarified and as a result the flow layers for the Infill Area and Badger South Area scenarios were modified. After the Master Plan meeting the following updates were added to the model:

- The land-use type was modified for the area directly south of the Bellerive Lift Station, between Leslie Road and Clearwater Avenue, based on pre-plat information.
- The land-use type was modified for areas adjacent to the Badger South development that are planned for future development. These areas include the Dallas Interchange Area, the Orchard Area, and the Wilson Area. (See Figure 1)
- A portion of the west half of the Badger South development was included. (See Figure 1) This area will be served by a new lift station that will discharge to the east and into the Leslie Interceptor. The remaining west half of the Badger South development is served by an existing lift station.
- A fifth scenario, Final Build-Out, was created and included the above listed updates and the existing Rancho Reata neighborhood to represent the entire potential drainage basin for the Bellerive Lift Station.

After the Master Plan meeting the resulting CIP projects were identified:

1. Construction of a new East Badger South lift station and force main. (As shown on Figure 1)
2. Extension of the Leslie Interceptor to the west boundary of the annexation area, parallel to I-82. (as shown of Figure 5)
3. Construction of a new Bellerive lift station and force main.

<u>CIP Project #1 – Construction of a new East Badger South Lift Station</u>

A new lift station was identified as a capital improvement to serve a sub-basin of the overall Bellerive Lift Station basin. This sub-basin consists of the Badger South development and the surrounding areas (Dallas Interchange, Orchard, and Wilson Areas) that will all convey gravity sewer flows to a common location. The sewer flows to the new lift station were based on the current and the proposed land use for each area and the corresponding unit flow as identified in Table 1. The proposed location for the lift station was based on the existing ground low point, east of the Badger South development which corresponds to the location shown on preliminary Badger South development plans. The lift station size was based on the hydraulic model results for the Final Build-Out scenario peak sewer flows for this sub-basin. Dual forcemain pipes will route the pumped sewer flows southwesterly from the lift station and toward the Reata Road overpass of I-82, then east along the interstate to the discharge manhole in the Annexation Area, as identified on Figure 5. During the Final Build-Out scenario, peak flows into the lift station were identified as 1,800 gpm. Although the developer's consulting engineer is completing the design of the lift station and the dual forcemain pipes, based on this peak pumping rate, the lift station design style will likely be a trench style lift

station. This style is different from the City standard submersible pump style lift station and will be further discussed in CIP Project #3. An Engineer's Opinion of Probable Cost prepared by the developer's consulting engineer is included in the Appendix for reference.

CIP Project #2 – Extension of the Leslie Interceptor

The existing Leslie Interceptor pipe is 18-inches in diameter and is stubbed across Leslie Road to the northeast corner of the Annexation Area. The extension of the interceptor from the north east corner to the west boundary of the Annexation Area (See Figure 5) will provide sewer infrastructure to the Annexation Area development and will provide a tie-in point for the discharge of the Badger South development and adjacent areas. A review of Figure 1 identifies these areas and lists the proposed locations of both the West-Badger South lift station and the East-Badger South lift station. Note that the existing grade of the Dallas Interchange Area will equally divide sewer flows, half to the West-Badger South lift station and half to the East-Badger South lift station. Table 3 lists the peak pumping rates for each Badger South lift station during the Final Build-Out scenario:

TABLE 3 – BADGER SOUTH LIFT STATION FLOWS

Badger South Lift Station	Peak Pumping Rate (gpm)
West	500
East	1,800

In planning for the extension of the Leslie Interceptor, at minimum slope (0.12%) an 18-inch PVC pipe can convey approximately 1,600 gpm (d/D of 0.75). This indicates that pipe submergence would occur given the flows from the Final Build-Out scenario. Existing ground contours for the annexation area indicate that the majority of the interceptor extension could be constructed at a slope greater than 0.12%, which would increase the flow capacity of an 18-inch pipe and reduce the chance of pipe submergence. It is important to note that the existing ground contours used in developing the alignment were based off the 2012 Benton County fly-over survey that generated 2-ft GIS contours referencing the NAVD88 vertical datum. These contours indicate that the pipe could be constructed at a slope as steep as 2.0%, however a topographical survey must be conducted prior to the design phase to verify the minimum slope of any pipe in the extension, and also confirm the depth necessary to serve all parcels in the service area. Based upon these GIS contours, hydraulic modeling identified a combination of 15-inch pipe and 18-inch pipe would convey peak sewer flows. Figure 5 identifies pipe quantity and minimum grade for each with the transition between pipe sizes being located near the I-82 overpass of Clearwater Ave. The 15-inch pipe would need to be constructed at a minimum 1.3% slope while the 18-inch pipe would need to be constructed at a minimum 0.25% slope. At these pipe slopes the flow depth over pipe diameter (d/D) value would be less than 0.75 during peak sewer flows. Figure 5 also notes the approximate cover depth for the interceptor

extension. The pipe depth was controlled mainly by constructing lateral sewer services with a minimum depth of 6-feet and a minimum 2.0% slope to serve each parcel. For this CIP effort, an Engineer's Opinion of Probable Cost for the extension of 5,200 lineal feet of 15-inch and 18-inch pipe was prepared and is included in the Appendix.

The downstream pipe capacity of the existing Leslie Interceptor was also analyzed during the Final Build-Out scenario. Note that this scenario also includes flows from Rancho Reata so as to include the entire Bellerive Lift Station basin area. As shown in Figure 6, during peak flow conditions approximately 1,600 lineal feet of the 18-inch interceptor would be submerged (1.00 - 1.50) with the remaining length having depth over diameter (d/D) values ranging from 0.25 to 1.00. While pipe submergence is not expected to be an operational concern at this location due to the lack of nearby residences with basements, it will be a maintenance concern with the potential to increase the deposition of solids and limit the entrainment of fresh air and oxygen into the wastewater, therefore increasing the frequency of flushing and TV inspection. A separate project to replace this section of the interceptor pipe or to construct a secondary bypass pipe is included in the Meadow Springs Interceptor discussion of the CIP project alternatives. It should be noted that if the Rancho Reata and Orchard areas are not included in the drainage basin, the submergence does not occur.

CIP Project #3 – New Bellerive Lift Station

The need for an increase to the pumping capacity of the Bellerive Lift Station was identified at the master planning level and was identified in the City's 2004 General Sewer Plan. The existing lift station consists of a 6-foot diameter wet well with a duplex pump set-up and an existing pumping capacity of 300 gpm per pump. Design capacity for this lift station was based upon available downstream capacity. The small wet well diameter limits future expansion with larger pumps and therefore any increase of the pumping capacity. Since all the scenarios identify downstream pipe submergence as an impact to the existing collection system, new system improvements are needed to address these deficiencies. Table 4 lists the peak flow rates into the Bellerive Lift Station based on each scenario:

TABLE 4 – BELLERIVE LIFT STATION PEAK FLOWS

#	Scenario	Peak Flow Rate (gpm)
1	Existing System	100
2	Infill Area	450
3	Annexation Area	515
4	Badger South Area	1,800
5	Final Build-Out	2,800

The Phase 2 expansion of the Bellerive Lift Station was identified in the 2004 General Sewer Plan and the timing of the project was noted to be development driven. Although the City's

standard for new lift stations consist of a concrete wet well with submersible pumps, to accommodate the range of peak flows and the required peak pumping capacity, the new Bellerive Lift Station would instead be a trench style lift station. This style of lift station allows for a modular approach to increasing the pumping capacity and more efficient O&M. Future pumps can be added as flows to the lift station increase. The design also features a self-cleaning spillway at the influent pipe invert that directs flows toward the pumps. Based on the Final Build-Out scenario, the new Bellerive Lift Station would be sized for a peak flow of approximately 4.0 mgd (2,800 gpm).

In addition to constructing a new lift station, a larger pressure force main will also be required. Due to the range of pumping rates, the force main will likely consist of dual force main pipes, one small and one large, to help maintain self-cleaning velocities. The dual force main pipes will be routed west on Broadmoor Street to Leslie Road and then north on Leslie to an existing manhole near the intersection of Canyon Street. The dual force main pipes will then discharge into an existing 21-inch trunk pipe with an existing reserve capacity of greater than 15 mgd. For this CIP effort, an Engineer's Opinion of Probable Cost for a new 4.0 mgd, trench style, Bellerive lift station and 11,000 lineal feet of 8-inch and 12-inch dual force main pipes was prepared and is included in the Appendix.

CIP PROJECT ALTERNATIVES

The largest lift station in the City is currently the Waterfront lift station with a rated capacity of 600 gpm. The addition of two large, regional lift stations (East-Badger South – 1800 gpm and Bellerive Phase 2 – 2,800 gpm) would be significant pieces of infrastructure that require considerable O&M. Therefore two gravity sewer pipe alternatives were considered in an effort to mitigate the need for these large pumping stations.

<u>Meadow Springs Interceptor-</u>

As an alternative to a new 4.0 mgd Bellerive Lift Station and dual force mains, a gravity pipe extension of the Leslie Interceptor was considered. It would extend approximately 11,000 lineal feet, from the existing Bellerive Lift Station, across the Meadow Springs golf course, under Gage Blvd, and follow Amon Drive before connecting to the existing 21-inch trunk pipe in Leslie Road. The alignment is shown in Figure 7 and is titled the Meadow Springs Interceptor. The interceptor would eliminate the need to build a new Bellerive lift station. This project could also include the necessary upgrade to the 1,600 lineal feet of existing 18-inch Leslie Interceptor piping that was identified in the CIP Project #2 discussion. The planning-level alignment shown was based on the following: deepening the sewer connection at the Bellerive Lift Station to capture all incoming sewer flows, limiting the number of pipe crossings of the Amon Wasteway, connecting to the existing sewer manhole at Gage Blvd. to capture existing sewer flows, and locating the sewer utility within public right-of-way, where possible. It is

important to note that the existing ground contours used in developing the alignment, manhole rim elevations, and interceptor pipe inverts were based off the 2012 Benton County fly-over survey that generated 2-ft GIS contours referencing the NAVD88 vertical datum. The majority of the record drawings for this area of Richland reference the NGVD29 vertical datum. Elevation differences between these two datum's can range from 2.50-ft to 3.50-ft depending on location; therefore in our model we adjusted the GIS contours by a value of (-) 3.25-ft as this was the common difference observed in this area. In any case, a topographic survey of the proposed alignment must be completed prior to the design phase to verify interceptor pipe grade and alignment.

Hydraulic modeling for this alternative was based on the Final Build-Out scenario. Peak flows for the Meadow Springs Interceptor, south of Gage, through the golf course were identified as 4.0 mgd. While a 21-inch PVC pipe, at minimum slope (0.10%), can convey approximately 2.6 mgd (d/D of 0.75), existing ground contours in the golf course indicate that the interceptor could be constructed at a slope greater than 0.10%. Constructing the interceptor at 0.18% slope will increase the flow capacity of a 21-inch pipe to approximately 4.3 mgd (d/D of 0.75).

Based on the Final Build-Out scenario, the hydraulic model identified peak flows for the Meadow Springs Interceptor, north of Gage Blvd, as 5.9 mgd. The increase in flow is due to the additional sewer basins that currently convey flows into the existing 21-inch Canyon Terrace interceptor pipe. (See Figure 7 for interceptor location) Record drawings identify that this pipe was installed in 1972 and City GIS shows the pipe runs in an easement through many private yards and near several private homes within the Canyon Terrace neighborhood. The City noted a preference to relieve this interceptor of its existing flow and instead route all existing and future flows through the new Meadow Springs Interceptor within the public right-of-way. Figure 7 shows that the new Meadow Springs Interceptor would connect to the existing Canyon Terrace interceptor at the top of Leslie Road before it drops downhill. To connect to the existing interceptor at this location, the average pipe slope required would be approximately 0.18%. A 24-inch pipe constructed at this grade can convey approximately 6.0 mgd (d/D of 0.75). Figures 8 and 9 identify the reserve capacity (mgd) and depth over diameter (d/D) values for the Meadow Springs Interceptor.

Regarding its construction, the alignment for the Meadow Springs Interceptor was based on the assumption that open-trench construction methods would be employed. The presence of groundwater will be an added complication during construction. Construction scheduling will be key in order to minimize the required dewatering effort as it is assumed that the groundwater level closely mirrors irrigation season. For the golf course crossing, there is one location where the existing Amon Wasteway may result in shallow pipe cover. This location is identified on Figure 7 and is just south of Gage Blvd. Depending on the selected construction

method, the existing Amon Wasteway may be impacted and would require restoration. The golf course crossing itself will also impact several of the existing fairway and rough areas. Site restoration would include repair to the turf grass and to the irrigation piping.

North of the golf course, the interceptor would cross under Gage Blvd. It was assumed that this pipe crossing could be constructed by jacking and boring a steel casing pipe under the roadway. The interceptor pipe would then be installed through the casing. This construction method, versus open trench, would reduce the impact to traffic on Gage Blvd. and keep the roadway open. North of the Gage Blvd. crossing, the interceptor would typically follow the existing road right-of-way to its point of connection. It was assumed that the old railroad embankment crossing would be constructed by open trench construction.

For this CIP alternative, an Engineer's Opinion of Probable Cost for the extension of 11,000 lineal feet of 21-inch and 24-inch pipe was prepared and is included in the Appendix.

Reata Canyon Interceptor

As an alternative to a new lift station in the Bellerive Lift Station sub-basin, a gravity pipe alternative through Reata Canyon was considered. The interceptor pipe would convey flows from the sub-basin to the existing Leslie Interceptor in Leslie Road. The interceptor would be approximately 13,500 lineal feet with 7,000-feet constructed in existing roadways and 6,500-feet in Reata Canyon. The alignment is shown in Figure 10 and is titled the Reata Canyon Interceptor.

As noted in the previous section, the existing ground contours used for the hydraulic modeling were based on the GIS data from the 2012 Benton County fly-over survey which reference the NAVD88 vertical datum; however there is approximately 280-feet of vertical fall over the entire alignment length which results in an average existing grade slope of approximately 2% and therefore there is significant elevation relief for this alignment.

Hydraulic modeling for this alternative was based on the Final Build-Out scenario. Peak flows for the Reata Canyon Interceptor were identified as 2.5 mgd. As previously described, the existing ground contours along the proposed alignment create an existing grade of approximately 2%. A 15-inch pipe constructed at this slope can convey approximately 5.4 mgd (d/D of 0.75) and therefore would provide adequate capacity. Future coordination with the proposed sewer pipe sizes in the Badger South development should be completed prior to a final interceptor size selection is made, to prevent a downstream decrease in pipe diameter or grade.

The alignment for the Reata Canyon Interceptor was selected based on existing ground contours provided by the County fly-over. Topographic survey would be necessary for design

phase. It was assumed that construction within the existing roadways would be accomplished by open-trench construction. The alignment through the existing canyon would require both a permanent easement and a construction easement. Existing plats for the El Rancho Reata neighborhood were obtained from the Benton County Planning Department and identify that the majority of parcels along Reata Canyon share a common boundary at the low-point of the canyon. The plats also document several existing easements through and across Reata Canyon. These easements include a crossing for a buried potable water main pipe and for a buried irrigation water siphon. Coordination with these utilities would be integral to the design phase. Additionally, the existing canyon has limited equipment access and existing ground appears to be near bedrock in some areas. An independent geotechnical evaluation would be needed ahead of the design phase. The planning department also noted that there are existing wetland areas along the canyon route that would require further investigation.

For the quantity of pipe located in the existing roadways, open trench construction was assumed. The method of construction for the interceptor pipe through the canyon should be further evaluated prior to design to identify which, if any, trenchless construction methods would apply to reduce the construction impact to the canyon (i.e., limit or eliminate the number of manholes needed along the pipeline). Recent discussions with directional drilling contractors (one method of trenchless construction) identified that directional drilling typically requires a minimum pipe slope of 4% or greater due to its inherent limited precision and grade control, especially in rocky conditions, and would require a minimum pipe depth of approximately 20-feet to minimize the potential for leaking high pressure drilling mud used to remove soil and rock cuttings during the drilling process. If a geotechnical analysis indicates that directional drilling is feasible, one alternative may be a buried inverted sewer siphon which would convey sewer flows under pressurized conditions. Standard siphon design guidelines identify a smooth curve radius profile as ideal for facilitating cleaning and flushing. These guidelines note that any sag points in the vertical alignment may lead to a point of blockage, and thus require frequent maintenance and could lead to future failure. Maintaining a minimum average daily flow of 3 feet per second (fps) and providing for a peak flow velocity of 4 fps at least once a day are additional design requirements. For this reason, siphons typically consist of a dual barrel design which allow for phasing bypass capacity, emergencies and for use when the other barrel is taken off-line for maintenance or repairs. Sewer siphon design would likely also include the design of an airline (“air jumper”) to move the gravity pipe headspace air from the siphon inlet to the siphon outlet and to limit odors.

However, to identify all applicable pipeline construction methods, a thorough and complete geotechnical evaluation should be completed that includes a discussion regarding which trenchless technology construction methods would be best suited for this location. For this planning level analysis, the quantity of pipe located in the canyon was assumed to be

constructed by open trench construction with increased manhole spacing of 1,000-feet. Note that depending on the construction method identified in the geotechnical report, the current construction costs may be greater.

For this CIP alternative, an Engineer's Opinion of Probable Cost for the extension of 13,500 lineal feet of 15-inch pipe was prepared and is included in the Appendix.

Present Worth Analysis

To evaluate these gravity pipeline alternatives versus the regional lift station CIP projects identified during master planning, a present worth analysis was prepared based upon 50 years of operation, maintenance and replacement for each CIP project considered. The development of each lift station alternative assumed initial flows would last for 10 years, intermediate flows would last for 15 years and build-out flows would be reached at year 25. Table 5 summarizes each CIP project construction cost and the present worth of annual O&M costs as well as the totals for each CIP project.

TABLE 5 – 50-YEAR PRESENT WORTH ANALYSIS[1]

CIP Project Name	Engineer's Opinion of Probable Cost (in million $)	O&M Present Worth (in million $)	Total Costs (in million $)
New Bellerive LS (4.0 mgd)	5.1	1.7[5]	6.8
Meadow Springs Interceptor	5.2	0.2	5.4
East Badger South LS (2.5 mgd)	3.8[2]	2.0[5]	5.8
Reata Canyon Interceptor[3]	2.9[3,4]	0.2	3.1

[1]This analysis assumes a 2.5% inflation rate and a 3.9% discount rate as per OMB Circular A-94, Appendix C, revised December 2013. All values are in 2013 dollars.

[2]Value based on the Engineer's Opinion of Probable Cost prepared by AHBL. Items 1, 2, and 3.

[3]Construction of the Reata Canyon Interceptor will also reduce the necessary size for the sewer extension to the Annexation Area to 8-inch. This value represents the interceptor cost less the cost for the difference in pipe size.

[4]Easement acquisition costs were also added to this value. See *Easement Acquisition* matrix in the Appendix.

[5]East Badger South LS has a larger static lift compared to the Bellerive LS and therefore will have a higher cost for pump power usage.

The table identifies the difference between CIP project alternatives in similar areas. In each case, the gravity pipe alternative has a lower 50-year cost compared to the regional lift station alternative.

APPENDIX

Easement Acquisition Matrix

Figure #	Parcel Number	Owner	Address	Parcel Area (Acre)	Land Value[1]	Land Value per Sq Ft	Permanent Esm't Value (90% LV)[4]	Permanent Esm't Area (Sq Ft)[2]	Permanent Esm't Cost (based on Land Value)
1	134983020000003	THOMPSON MATT C	91406 E CHELSEA RD,KENNEWICK,WA,99338	2.50	$56,000	$0.51	$0.46	3000	$1,387.32
2	134983020000002	MCCARTNEY MYLES A	91401 E CHELSEA RD,KENNEWICK,WA,99338	2.50	$56,000	$0.51	$0.46	3000	$1,388.43
3	103882020003043	MAUTH JEFFERY A & DIAN A	708 MANZANITA CT,KENNEWICK,WA,99336,	4.63	$58,080	$0.29	$0.26	6542	$1,694.41
4	103882020003019	RUEGSEGGER BRIAN A & DEBORAH E	94702 E GRANADA CT,KENNEWICK,WA,99338-88	3.46	$52,470	$0.35	$0.31	412	$129.00
5	103882020003018	WIDERGREN TRUSTEES STEVEN E & TERRI	94806 E GRANADA CT,KENNEWICK,WA,99338-88	5.26	$60,810	$0.27	$0.24	14284	$3,410.56
6	103882020003017	HAECKER CHRISTOPHER F & M	94905 E GRANADA CT,KENNEWICK,WA,99338,US	9.30	$72,900	$0.18	$0.16	15598	$2,525.47
7	103883020005016	HOPPE JANICE L	3108 S CABALLO RD,KENNEWICK,WA,99338,	3.20	$51,660	$0.37	$0.33	997	$332.54
8	103881020004028	SCHUR BRIAN L & CARA	1604 S JURUPA ST,KENNEWICK,WA,99338-9394	3.22	$51,630	$0.37	$0.33	6803	$2,257.02
9	103883020005017	ESTLE RICK	3112 S CABALLO RD,KENNEWICK,WA,99338,	3.27	$51,810	$0.36	$0.33	2788	$913.07
10	103881020004029	RUSSELL VICTORIA B	1705 S JURUPA,KENNEWICK,WA,99338,	3.05	$51,150	$0.39	$0.35	3672	$1,273.21
11	103883020005018	KITE FRED J & MERLE ANN	3118 S CABALLO RD,KENNEWICK,WA,99338,	2.09	$48,270	$0.53	$0.48	782	$373.65
12	103883020005019	JOHNSON ERIC	3122 S CABALLO RD,KENNEWICK,WA,99338-937	3.73	$53,160	$0.33	$0.29	7532	$2,220.23
13	103884012545004	WILLIAMS JOHN DAVID	3230 S WALNUT RIDGE PRSE,KENNEWICK,WA,99	4.54	$74,180	$0.38	$0.34	2236	$755.31
14	103883020005020	WILLIS RANDY J & NADINE E	3126 S CABALLO RD,KENNEWICK,WA,99338-937	6.13	$63,390	$0.24	$0.21	7609	$1,625.81
15	103884012545003	LEWALLEN WESLEY B & TRICIA A	3320 S WALNUT RIDGE PR SE,KENNEWICK,WA,9	4.61	$55,060	$0.27	$0.25	3152	$777.40
16	103883020005023	WIEGMAN TRUSTEE STEPHEN A	99215 E CABALLO PL,KENNEWICK,WA,99338,	4.44	$56,640	$0.29	$0.26	9622	$2,536.11
17	103883020002014	CARROLL ROBERT W	101210 E VACA RD,KENNEWICK,WA,99338,	3.87	$53,640	$0.32	$0.29	5633	$1,615.33
18	103883020002015	SILVERNAIL PAUL J SR & PATRICIA M	101306 E VACA RD,KENNEWICK,WA,99338-9337	3.35	$51,990	$0.36	$0.32	4157	$1,334.61
19	102883020002015	ATKIN SHARON D	101704 E VACA RD,KENNEWICK,WA,99338,	1.13	$36,000	$0.73	$0.66	1527	$1,008.94
20	102883020002014	FICK TRUSTEES MICHAEL H & KAREN KAY	102004 E VACA RD,KENNEWICK,WA,99338,	1.31	$37,800	$0.66	$0.59	2702	$1,605.80
21	102883020002013	HARRIS DANIEL	102204 E VACA RD,KENNEWICK,WA,99338-9304	1.45	$39,600	$0.63	$0.57	3753	$2,120.43
22	102883020002012	OLSEN DARRYLL	102402 E VACA RD,,,KENNEWICK,WA,99338,US	1.81	$39,600	$0.50	$0.45	4703	$2,120.75
23	102883020002011	HUTZELMAN CHRISTOPHER A & DONNA M	102604 E VACA RD,KENNEWICK,WA,99338,USA	1.50	$39,600	$0.61	$0.54	3939	$2,146.25
24	102883020002010	STEFFEN JIM M & MIRIAM	102904 E VACA RD,KENNEWICK,WA,99338,	0.95	$39,600	$0.95	$0.86	683	$585.22
25	102883020002009	MILLER DUSTIN W & KAYLA J	103102 E VACA RD,KENNEWICK,WA,99338-9342	1.05	$39,600	$0.86	$0.78	1404	$1,090.51
26	102883020002008	SKLINCHAR JAREL	103306 E VACA RD,KENNEWICK,WA,99338,USA	1.98	$39,600	$0.46	$0.41	5309	$2,193.13
27	102883012795002	PETERSON MICHAEL R & ANN M	2860 JACOB CT,KENNEWICK,WA,99338,	4.63	$63,000	$0.31	$0.28	2125	$597.09
28	102883030003009	CIESLAR MATTHEW & WHITNEY	3002 ESCOLAR RD,KENNEWICK,WA,99338-7332,	1.90	$46,750	$0.56	$0.51	6980	$3,548.60
29	102883012999003	KENNEWICK SCHOOL DISTRICT #17	280 LESA MARIE LN,KENNEWICK,WA,9	20.27	$439,860	$0.50	$0.45	19399	$8,697.42
								Totals	$52,263.60

Notes:

1. As per Benton County's Assessor Website
2. Based on a 20-ft wide permanent sewer easement. Area obtained from from GIS base map.
3. Based on a 50-ft wide easement for construction. Area obtained from GIS base map.
4. Costs and percentages provided by City of Richland

Permanent Esm't Value (10% LV)[4]	Construction Esm't Area (Sq. Ft)[3]	Construction Esm't Cost[4]	Total Permanent + Construction Esm't Cost	Appraisal Cost[4]	Negotiation Cost[4]	Rev Cost[4]	Title Cost/PM[4]	Subtotal (Sum of Columns Z - AD)	Contingency (35% of Subtotal)[4]	Eval	Total Cost (Sum of Columns AE - AG)
$0.05	7500	$385.37	$1,772.69	$1,200	$1,250	$800	$1,100	$6,123	$2,143	$ 200	$8,466
$0.05	7500	$385.67	$1,774.10	$1,200	$1,250	$800	$1,100	$6,124	$2,143	$ 200	$8,468
$0.03	16447	$473.28	$2,167.69	$1,200	$1,250	$800	$1,100	$6,518	$2,281	$ 200	$8,999
$0.03	1032	$35.90	$164.90	$1,200	$1,250	$800	$1,100	$4,515	$1,580	$ 200	$6,295
$0.03	32335	$857.83	$4,268.39	$1,200	$1,250	$800	$1,100	$8,618	$3,016	$ 200	$11,835
$0.02	32710	$588.47	$3,113.93	$1,200	$1,250	$800	$1,100	$7,464	$2,612	$ 200	$10,276
$0.04	2494	$92.39	$424.93	$1,200	$1,250	$800	$1,100	$4,775	$1,671	$ 200	$6,646
$0.04	13886	$511.93	$2,768.95	$1,200	$1,250	$800	$1,100	$7,119	$2,492	$ 200	$9,811
$0.04	10044	$365.47	$1,278.54	$1,200	$1,250	$800	$1,100	$5,629	$1,970	$ 200	$7,799
$0.04	7770	$299.33	$1,572.54	$1,200	$1,250	$800	$1,100	$5,923	$2,073	$ 200	$8,195
$0.05	3542	$188.05	$561.70	$1,200	$1,250	$800	$1,100	$4,912	$1,719	$ 200	$6,831
$0.03	18697	$612.39	$2,832.62	$1,200	$1,250	$800	$1,100	$7,183	$2,514	$ 200	$9,897
$0.04	8078	$303.16	$1,058.47	$1,200	$1,250	$800	$1,100	$5,408	$1,893	$ 200	$7,501
$0.02	16778	$398.34	$2,024.15	$1,200	$1,250	$800	$1,100	$6,374	$2,231	$ 200	$8,805
$0.03	10843	$297.12	$1,074.53	$1,200	$1,250	$800	$1,100	$5,425	$1,899	$ 200	$7,523
$0.03	20845	$610.50	$3,146.60	$1,200	$1,250	$800	$1,100	$7,497	$2,624	$ 200	$10,320
$0.03	14082	$448.66	$2,063.99	$1,200	$1,250	$800	$1,100	$6,414	$2,245	$ 200	$8,859
$0.04	10391	$370.73	$1,705.34	$1,200	$1,250	$800	$1,100	$6,055	$2,119	$ 200	$8,375
$0.07	2826	$207.47	$1,216.40	$1,200	$1,250	$800	$1,100	$5,566	$1,948	$ 200	$7,715
$0.07	4926	$325.31	$1,931.10	$1,200	$1,250	$800	$1,100	$6,281	$2,198	$ 200	$8,679
$0.06	7433	$466.64	$2,587.07	$1,200	$1,250	$800	$1,100	$6,937	$2,428	$ 200	$9,565
$0.05	11756	$589.06	$2,709.81	$1,200	$1,250	$800	$1,100	$7,060	$2,471	$ 200	$9,731
$0.06	9199	$556.84	$2,703.09	$1,200	$1,250	$800	$1,100	$7,053	$2,469	$ 200	$9,722
$0.10	2322	$221.24	$806.46	$1,200	$1,250	$800	$1,100	$5,156	$1,805	$ 200	$7,161
$0.09	2935	$253.29	$1,343.80	$1,200	$1,250	$800	$1,100	$5,694	$1,993	$ 200	$7,887
$0.05	11480	$526.97	$2,720.10	$1,200	$1,250	$800	$1,100	$7,070	$2,475	$ 200	$9,745
$0.03	8102	$252.95	$850.04	$1,200	$1,250	$800	$1,100	$5,200	$1,820	$ 200	$7,220
$0.06	14736	$832.38	$4,380.98	$1,200	$1,250	$800	$1,100	$8,731	$3,056	$ 200	$11,987
$0.05	48496	$2,415.91	$11,113.33	$2,000	$1,250	$800	$1,100	$16,263	$5,692	$ 200	$22,155
		$13,872.64	$66,136.24					$193,086.24			$266,500

Planning Level Assumptions for O&M Present Worth Calculations

General Information

i = 3.90% (Interest Rate/Discount Rate)
f = 2.50% (Inflation Rate)
pc = $ 0.070 $/ kWh (Power Cost)

Maintenance & Replacement Information

Gravity Piping

Jetting & Cleaning every 3 yrs with a cost of $0.35 per LF
TV Inspection every 10 yrs with a cost of $1.20 per LF

Trench Style Lift Stations

Replace odor control media every 2 years
Upgrade Mechanical based on flow development trigger (0-10 initial, 10-25 intermediate, > 25 build-out) at a cost of 25% original project item cost
Replace facility electrical every 15 years at a cost of 25% original project item cost
Replace HVAC system every 15 years at a cost of 25% original project item cost
Pump Run Time Assumption = 12 hours per day

AHBL

CIVIL & STRUCTURAL ENGINEERS • LAND PLANNERS • LANDSCAPE ARCHITECTS • SURVEYORS

PROJECT: Badger Mountain South Sewer LID
PREPARED BY: Todd Sawin, PE
DATE: January 16, 2013

OPINION OF PROBABLE CONSTRUCTION COST

Item No	Description	Quantity	Unit	Unit Cost	Total	Notes
1	BMS-East Lift Station	1	ea	$1,500,000.00	$1,500,000.00	submersible pumps & backup power
2	Force Main B	8260	lf	$50.00	$413,000.00	8" force main and shoulder restoration (grass)
3	Force Main C	10800	lf	$50.00	$540,000.00	12" force main and shoulder restoration (grass)
4	Trunk Main 3	5800	lf	$65.00	$377,000.00	
5	Trunk Main 3a	1000	lf	$65.00	$65,000.00	
6	Trunk Main 4	6800	lf	$65.00	$442,000.00	
7	Grading for sewer	31000	cy	$5.00	$155,000.00	
8	Temporary Access Road	163200	sf	$0.50	$81,600.00	Assume 12' wide over length of gravity pipe, 4" thick
				Subtotal	$3,573,600	
				25% Contingency	$893,400	
				20% Engineering	$714,720	
				8.3% Sales Tax	$296,609	
				Total	$5,478,329	
				Use	$5,480,000	

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: LESLIE INTERCEPTOR EXTENSION DATE: 4/21/2014

PROJECT DESCRIPTION: 5,200 LF 18-IN & 15-IN INTERCEPTOR PIPE EXTENSION

CLIENT: CITY OF RICHLAND - SOUTH SEWER PLANNING

CLIENT PROJ. NO. J-U-B PROJ. NO.: 30-13-048

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization (8%)	1	LS	$40,000	$40,000
2	Clearing & Grubbing/Site Prep/Restoration	1	LS	$30,000	$30,000
3	Connect to Existing Pipe	1	LS	$1,500	$1,500
4	18" Interceptor Pipe - Solid Wall PVC				
	Less than 15-ft depth	500	LF	$60	$30,000
	Greater than 15-ft deep	400	LF	$85	$34,000
	15" Interceptor Pipe - Solid Wall PVC				
	Less than 15-ft depth	3,400	LF	$50	$170,000
	Greater than 15-ft deep	900	LF	$70	$63,000
5	48" Sanitary Sewer MH	13	EA	$3,000	$39,000
6	Imported Pipe Bedding	5,200	LF	$8	$41,600
	Planning Level Assumptions 1. No dewatering or rock excavation. 2. No traffic control required for construction adjacent to I-82 3. Minimal site restoration.				
	SUBTOTAL				$449,100
	BENTON COUNTY SALES TAX			8.30%	$37,275
	SUBTOTAL				$486,375
Contingency				25%	$121,594
Engineering/Construction Administration/Testing				20%	$89,820
				TOTAL ESTIMATED COSTS	$697,789

ZSW

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: BELLERIVE TRENCH STYLE LIFT STATION DATE: 4/4/2014

PROJECT DESCRIPTION: 4.0 MGD CAPACITY TRENCH STYLE LIFT STATION AND DUAL FORCE MAIN (11,000-FT)

CLIENT: CITY OF RICHLAND - SOUTH SEWER PLANNING

CLIENT PROJ. NO. J-U-B PROJ. NO.: 30-13-048

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization (8%)	1	LS	$215,000	$215,000
2	Site Work	1	LS	$40,000	$40,000
3	Yard Piping	1	LS	$5,000	$5,000
4	Lift Station - Structural	1	LS	$680,000	$680,000
5	Lift Station - Mechanical	1	LS	$350,000	$350,000
6	Lift Station - Electrical	1	LS	$390,000	$390,000
7	Lift Station - HVAC	1	LS	$58,000	$58,000
8	Lift Station - Odor Control	1	LS	$115,000	$115,000
9	Imported Backfill for Structure	1	LS	$30,000	$30,000
10	Dewatering - Site and Structure	1	LS	$100,000	$100,000
11	Dual Forcemain (8" & 12") and Roadway Trench Repair	1	LS	$1,150,000	$1,150,000
	Planning Level Assumptions 1. The existing Lift Station and Forcemain will be kept in service and used for local neighborhood flows due to the influent invert elevation. 2. The new Lift Station would be located south of the existing Lift Station on the City-owned parcel, east of Claybell Park. 3. The Lift Station - Structural item represents the cost for a formed, cast-in-place concrete facility with an above ground building to house electrical and odor control equip.				
	SUBTOTAL				$3,133,000
	BENTON COUNTY SALES TAX			8.30%	$260,039
	SUBTOTAL				$3,393,039
Permitting				5%	$169,652
Engineering/Construction Administration/Testing				20%	$678,608
Contingency				25%	$848,260
				TOTAL ESTIMATED COSTS	$5,089,559

ZSW

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: MEADOW SPRINGS INTERCEPTOR DATE: 4/22/2014

PROJECT DESCRIPTION: 11,000 LF 21-IN & 24-IN SEWER INTERCEPTOR PIPE

CLIENT: CITY OF RICHLAND - SOUTH SEWER PLANNING

CLIENT PROJ. NO. J-U-B PROJ. NO.: 30-13-048

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization (8%)	1	LS	$225,000	$225,000
2	Dewatering[1]	1	LS	$1,000,000	$1,000,000
3	Site Preparation	1	LS	$50,000	$50,000
4	Site Restoration	1	LS	$225,000	$225,000
5	Connect to Existing Structure	2	EA	$2,000	$4,000
6	21" Interceptor Pipe - Solid Wall PVC	7,000	LF	$100	$700,000
7	24" Interceptor Pipe - Solid Wall PVC	4,000	LF	$125	$500,000
8	48" Sanitary Sewer MH	41	EA	$3,500	$143,500
9	Gage Blvd. Crossing	1	LS	$180,000	$180,000
	Planning Level Assumptions 1. Dewatering for the entire length of the 21-inch interceptor was assumed and that the water could be cleaned and discharged to the Amon Wasteway. A complete environmental evaluation and geotechnical report is needed for further clarificiation.				
	SUBTOTAL				$3,027,500
	BENTON COUNTY SALES TAX			8.30%	$251,283
	SUBTOTAL				$3,278,783
Contingency				25%	$819,696
Permitting				15%	$454,125
Engineering/Construction Administration/Testing				20%	$605,500
				TOTAL ESTIMATED COSTS	$5,158,103

ZSW

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

ENGINEER'S OPINION OF PROBABLE COST

PROJECT:	REATA CANYON INTERCEPTOR	DATE:	4/22/2014
PROJECT DESCRIPTION:	13,500 LF 15-IN SEWER INTERCEPTOR PIPE		
CLIENT:	CITY OF RICHLAND - SOUTH SEWER PLANNING		
CLIENT PROJ. NO.		J-U-B PROJ. NO.:	30-13-048

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	Mobilization (8%)	1	LS	$130,000	$130,000
2	Rock Excavation[1]	1	LS	$150,000	$150,000
3	Site Preparation	1	LS	$50,000	$50,000
4	Site Restoration	1	LS	$300,000	$300,000
5	Connect to Existing Structure	2	EA	$2,000	$4,000
6	15" Interceptor Pipe - Solid Wall PVC	7,000	LF	$50	$350,000
7	16" Interceptor Pipe - Solid Wall HDPE	6,500	LF	$80	$520,000
8	48" Sanitary Sewer MH	30	EA	$4,400	$132,000
9	Bypass Piping/Pumping for Natural Drainage[2]	1	LS	$150,000	$150,000
	SUBTOTAL				$1,786,000
	BENTON COUNTY SALES TAX			8.30%	$148,238
	SUBTOTAL				$1,934,238
Contingency				25%	$483,560
Permitting				15%	$267,900
Engineering/Construction Administration/Testing				20%	$357,200
				TOTAL ESTIMATED COSTS	$3,042,898

Planning Level Assumptions

1. Rock excavation was assumed for 75% of the length of excavation within the canyon; however the exact quantity and type of subsurface rock is not known at this time and a complete geotechnical analysis is needed for further clarification.
2. Existing natural drainage flows were estimated to have a peak flow of 450 gpm (1.0 cfs) and bypass pumping of natural flows would be maintained by pump and generator. A complete environmental evaluation and geotechnical report is needed for further clarificiation.

ZSW

J-U-B ENGINEERS, INC.

SUITE 201, 2810 WEST CLEARWATER AVE., KENNEWICK, WASHINGTON 99336 (509) 783-2144

City of Richland
South Richland Sewer Planning

Figure 1
Study Area

Existing Collection System
- Annexation Area
- East-Badger South Dev.
- Part of West-Badger South Dev.
- Wilson Area
- Bellerive LS Basin
- City Limits
- Trunks
- Collectors

Lift Stations
- City

0 1,000 2,000 4,000
Feet

N W E S

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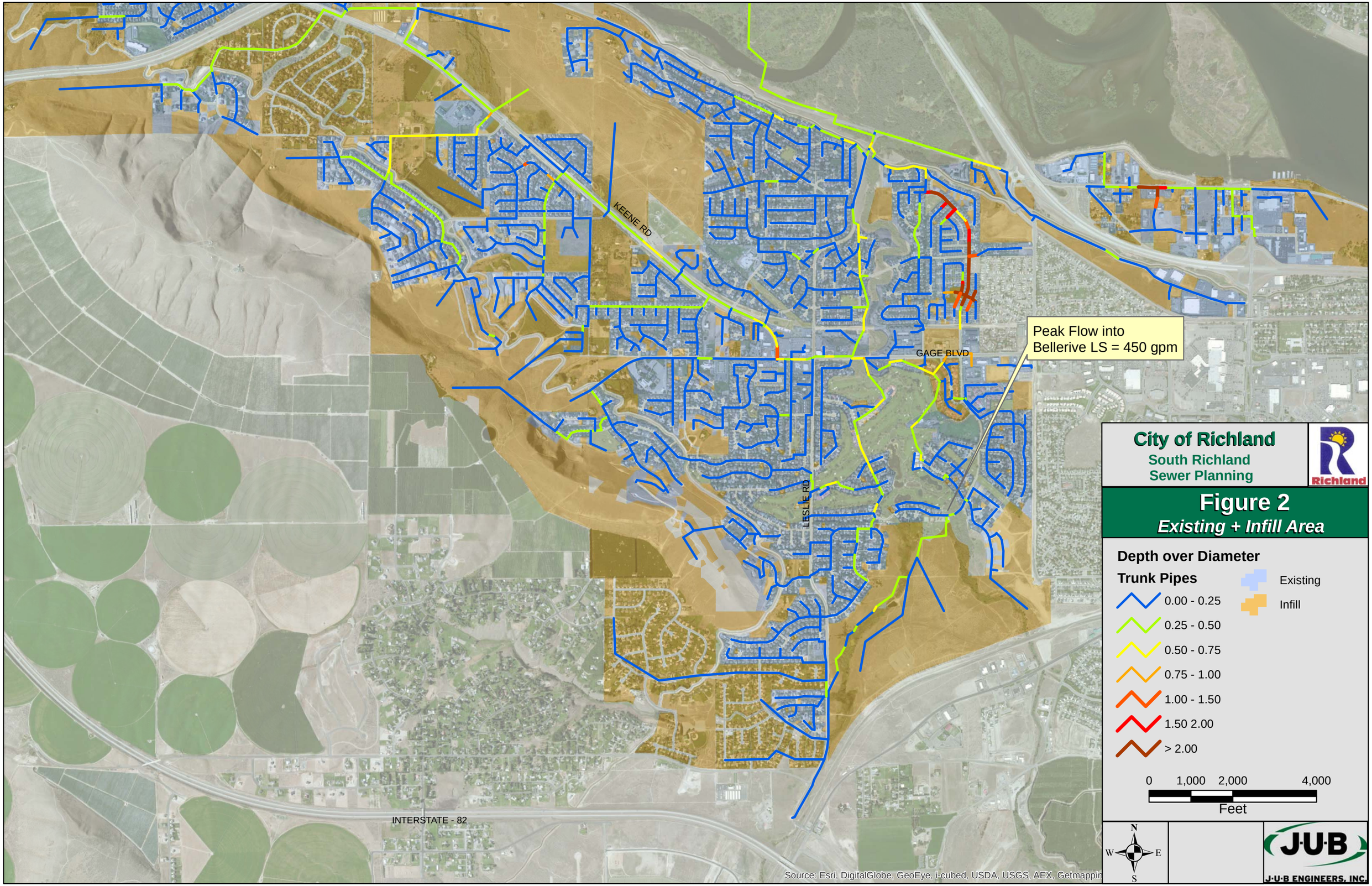
Country Ridge
DALLAS RD
BADGER MTN
KEENE RD
Existing West-Badger South LS (Serves the West-Badger South Area currently under developement)
Orchard Area Basin
West-Badger South Area (Under developement)
Wilson Area Basin
Meadow Hills
Proposed East-Badger South LS
Proposed West-Badger South LS
Part of West-Badger South Area
LESLIE RD
Bellerive LS
East-Badger South Area
Leslie Interceptor
Dallas Interchange Area
Annexation Area
INTERSTATE - 82

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


KEENE RD
GAGE BLVD
LESLIE RD
INTERSTATE - 82
Peak Flow into
Bellerive LS = 450 gpm
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmappin
City of Richland
South Richland
Sewer Planning
Richland
Figure 2
Existing + Infill Area
Depth over Diameter
Trunk Pipes
0.00 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.50
1.50 2.00
> 2.00
Existing
Infill
0
1,000
2,000
4,000
Feet
N
W
E
S
J·U·B
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KEENE RD

GAGE BLVD

LESLIE RD

INTERSTATE - 82

Peak Flow into
Bellerive LS = 515 gpm

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmappin

City of Richland
South Richland
Sewer Planning

Figure 3
Existing + Infill Area + Annex. Area

Depth over Diameter

Trunk Pipes

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Existing Area
- Infill Area
- Annex. Area

0 1,000 2,000 4,000
Feet

N
W E
S

J-U-B ENGINEERS, INC.

KEENE RD

GAGE BLVD

LESLIE RD

INTERSTATE - 82

Peak Flow into
Bellerive LS = 1,783 gpm

City of Richland
South Richland
Sewer Planning

Figure 4

Existing + Infill Area + Annex. Area + BMS Area

Depth over Diameter

Trunk Pipes

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Existing Area
- Infill Area
- Annex. Area
- BMS Area

0 1,000 2,000 4,000
Feet

N W E S

J-U-B ENGINEERS, INC.

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmappin

REATA ROAD

LESLIE ROAD

INTERSTATE - 82

Leslie Interceptor Extension Termination Manhole
Discharge Manhole for Badger South Force Main

Leslie Interceptor Extension
4,300 LF 15-in, min. 1.3% slope

Existing 18-in Leslie Interceptor

Connect to Existing Sewer
with new 18-in pipe

Leslie Interceptor Extension
900 LF 18-in, min. 0.25% slope

Pipe Size Transition
18-in to 15-in pipe

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmappin

City of Richland
South Richland
Sewer Planning

Figure 5
Leslie Interceptor Extension

Pipe Cover (ft)
- < 5
- 5 - 10
- 10 - 15
- 15 - 20

Annex. Area
EG Contours

Note: EG Contours based on 2012 Benton County fly-over on vertical datum NAVD88

0 200 400 800
Feet

N
W E
S

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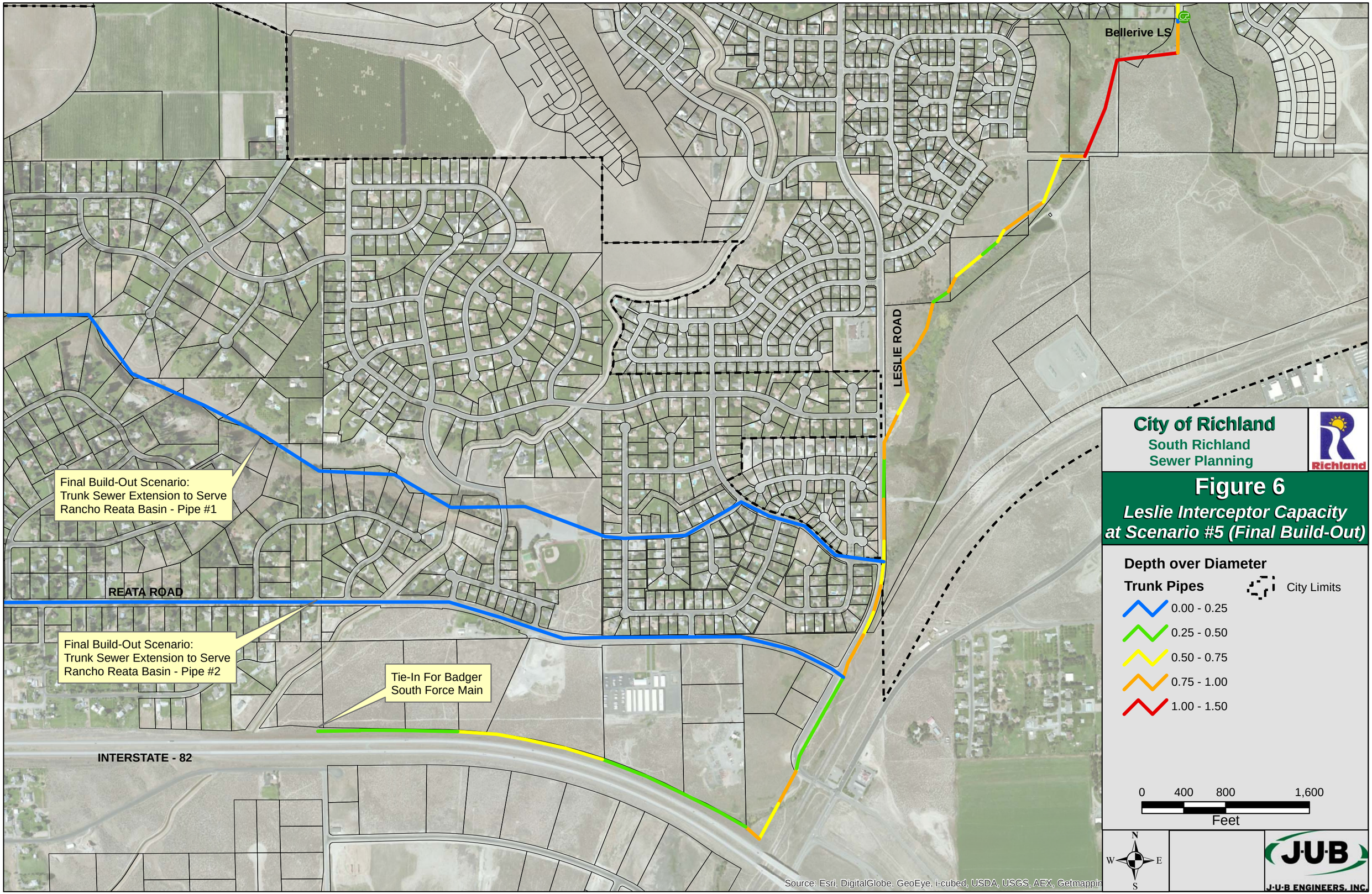
Bellerive LS
LESLIE ROAD
Final Build-Out Scenario:
Trunk Sewer Extension to Serve
Rancho Reata Basin - Pipe #1
REATA ROAD
Final Build-Out Scenario:
Trunk Sewer Extension to Serve
Rancho Reata Basin - Pipe #2
Tie-In For Badger
South Force Main
INTERSTATE - 82
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmappin
City of Richland
South Richland
Sewer Planning
Figure 6
Leslie Interceptor Capacity
at Scenario #5 (Final Build-Out)
Depth over Diameter
Trunk Pipes
0.00 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.50
City Limits
0
400
800
1,600
Feet
N
W
E
S
J-U-B
J-U-B ENGINEERS, INC.

Connect to Existing 21-in Sewer

LESLIE RD

AMON DRIVE

Existing 21-in Canyon Terrace Interceptor

Meadow Springs Interceptor
North of Gage Blvd
4,000 LF 24-in pipe @ min. 0.18%

AMON WASTEWAY

GAGE BLVD

Shallow Pipe Cover at Water Crossing

MEADOW SPRINGS CC

Meadow Springs Interceptor
golf course crossing
7,000 LF 21-in pipe @ min. 0.18%

Meadow Springs LS

Broadmoor LS
(Abandonded)

Bellerive LS

AMON WASTEWAY

Connect to Existing Sewer

alGlobe, GeoEye, i-cubed, USD
swisstopo, and the GIS User Community

City of Richland
South Richland
Sewer Planning

Figure 7
Proposed Pipe Size
Meadow Springs Interceptor

Pipe Size (in)
- 24
- 21
- 18
- 15
- 12
- 10
- Collectors

Lift Stations
- City

0 250 500 1,000
Feet

N W E S

J·U·B ENGINEERS, INC.

Connect to Existing 21-inch Sewer

LESLIE RD

Portions of the existing 21-inch Canyon Terrace interceptor will be left in tact to convey minor flows

GAGE BLVD

Meadow Springs Interceptor 11,000 18-in & 24-in pipe

MEADOW SPRINGS CC

Meadow Springs LS

Broadmoor LS (Abandonded)

Bellerive LS

Connect to Existing Sewer

City of Richland
South Richland Sewer Planning

Figure 8
Reserve Capacity Meadow Springs Interceptor

Reserve Capacity (mgd)

Trunk Pipes	Lift Stations
Over Capacity	City
0.01 - 0.25	
0.25 - 0.50	
0.50 - 1.00	
1.00 - 1.50	
1.50 - 2.00	
2.00 - 3.00	
3.00 - 5.00	
5.00 - 10.00	
> 10.00	

0 250 500 1,000
Feet

N W E S

J·U·B ENGINEERS, INC.

alGlobe, GeoEye, i-cubed, USD
swisstopo, and the GIS User Community

Connect to Existing 21-inch Sewer

LESLIE RD

Portions of the existing 21-inch Canyon Terrace interceptor will be left in tact to convey minor flows

GAGE BLVD

Meadow Springs Interceptor
11,000 LF 18-in & 24-in pipe

MEADOW SPRINGS CC

Meadow Springs LS

Broadmoor LS
(Abandonded)

Bellerive LS

Connect to Existing Sewer

City of Richland

South Richland Sewer Planning

Figure 9

Depth over Diameter Meadow Springs Interceptor

Trunk Pipes

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50

Lift Stations

- City

0 250 500 1,000

Feet

N W E S

DigitalGlobe, GeoEye, i-cubed, USDA, swisstopo, and the GIS User Community

J·U·B ENGINEERS, INC.

City of Richland

South Richland
Sewer Planning

Richland

Figure 10

Proposed Pipe Alignment
Reata Canyon Interceptor

New Pump Station Location

3,000 LF 15-in PVC pipe

6,500 LF 16-in HDPE pipe

Manhole Spacing Shown at 1,000-ft Separation Assuming Limited Open-Trench Construction

Reata Road

4,000 LF 15-in PVC pipe

Existing Leslie Interceptor Sewer

Pipe Material

- PVC Pipe Segment
- HDPE Pipe Segment
- Existing Richland Sewer
- Lot Parcel

0 400 800 1,600

Feet

N W E S

Date: April 4, 2014

J-U-B

J-U-B ENGINEERS, INC.

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community