Memorandum

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To	Matthew Arnold, SERA Tom Puttman, Puttman	Date	September 13, 2012
Copies		Reference number	224981
From	Grant McInnes, Arup Aihua Tang, Arup	File reference	2-02
Subject	Foster Lents Investment Corridor - Preliminary H&H Analysis		

Matthew and Tom,

Arup has developed potential flood-mitigation scenarios with a view to optimizing potential land values adjacent to Foster Road and evaluated them with Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling. The following is a brief summary of the preliminary analysis, results, and suggested next steps.

Flood-Mitigation Goals

Per Arup's kick-off meeting with Portland Bureau of Environmental Services (BES) staff, we have established the following flood-mitigation goals:

- Eliminate flooding on Foster Road under 25-year and/or 100-year flood scenarios,

- Remove the lands with the greatest potential development value from the 25-year and/or 100-year floodplain.

- Utilize land with the least development value as flood storage areas.

- Limit the 100-year peak flow within Johnson Creek downstream of the project area (at I-205) such that it does not exceed the existing condition.

- Address the City of Portland's balanced cut/fill requirement. Given the regional scale of the contemplated development, it may not be possible to comply with the City's requirement to balance cut/fill on individual parcels. A regional approach to balancing cut/fill may be more appropriate.

This preliminary analysis assesses which parcels of land could be available as future additional flood storage, how the storage areas could be connected hydraulically, and the potential benefits to more valuable parcels.

Existing Flood Storage Areas

Based on the previous studies (by others) and the existing condition HEC-RAS modeling results (provided by BES), the 100-year flood will spill over the north and south banks of Johnson Creek, causing flooding on Foster Road and adjacent land.

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Figure 1 illustrates the HEC-RAS layout of the existing conditions showing the approximate locations and relationship of these flood storage areas.
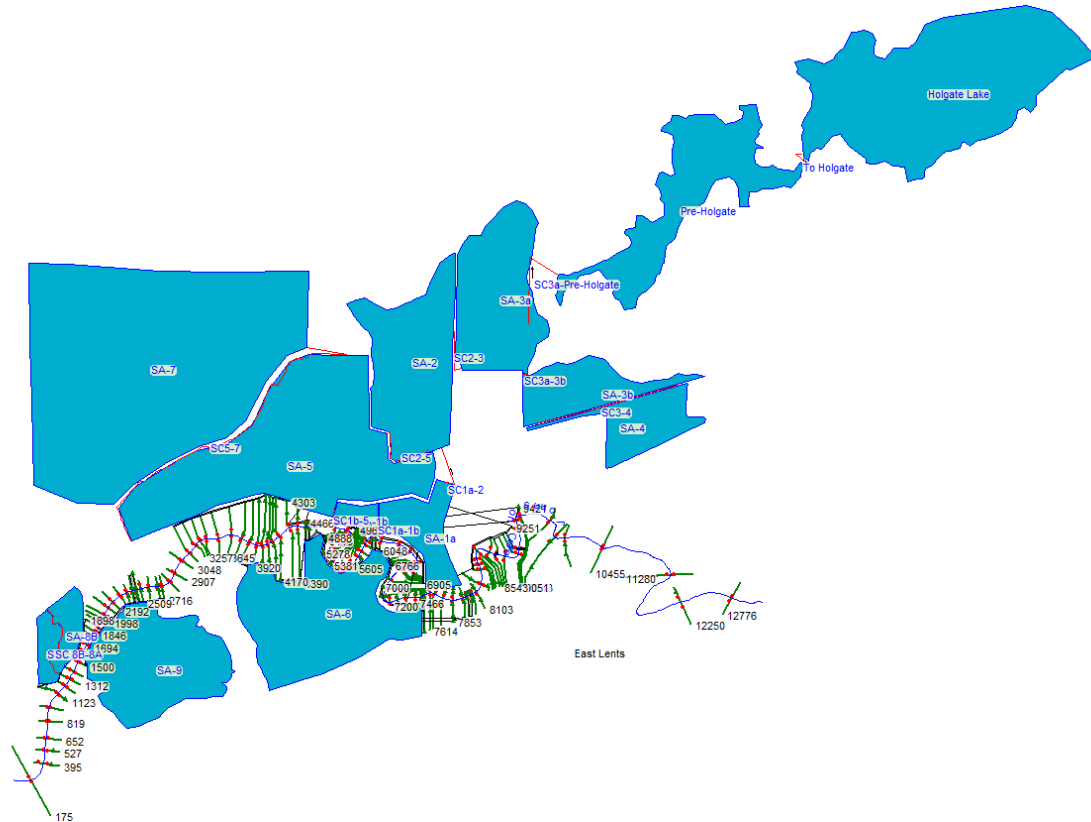

Figure 1 100-year flood storage areas — existing condition (hydraulic model)

South of Foster Road, the 2009 flood boundary exceeded the 100-year FEMA boundary in some areas (SA-9). The City is aware of this potential discrepancy, which is currently being resolved by a Conditional Letter of Map Revision study that may amend the 100-year FEMA boundary.

North Bank

During a 100-year event, flood waters overtopping the north bank of Johnson Creek will overtop Foster Road and sheet flow in the following directions:

- northeast — Most flow will sheet flow through a commercial and industrial area between Foster Road and Springwater Corridor Trail on both sides of 111th Avenue (HEC-RAS Storage Area 1-a [SA1-a]) and discharge toward Beggars-Tick Wildlife Refuge (SA-2). Flow overtopped from Beggars-Tick Wildlife Refuge will be discharged to the existing floodplain/wetland restoration areas and the adjacent residential and industry areas (SA-3a, SA-3b, and SA-4). Portions of the flow will overflow at the eastern boundary of SA-3a toward Holgate Lake.

- northwest — Floodwater will flow west along Foster Road and sheet flow across Springwater Corridor Trail and commercial and industry areas (SA-5), and toward a residential area (SA-7).

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- Return to downstream reach — Water will return to Johnson Creek at downstream cross sections where water surface elevations are lower.

South Bank

During a 100-year flooding event, flood waters overtopping the south bank of Johnson Creek will inundate an existing wetland on the northeast side of Brookside Park and a 50-plus-acre area that BES acquired, designed, and restored for flood storage and habitat improvements (SA-6). Waters will also inundate a portion of the Freeway Land Company site owned by Jameson Partners, LLC (SA-9).

The floodplain/flood storage areas will attenuate the 100-year peak flood through detention and retention. Portions of the flood water stored in these areas will return to Johnson Creek after the peak flow in the channel has passed.

Flood Boundary Comparison

Exhibit A presents the flood boundaries of the January 2009 flood event and the 100-year Federal Emergency Management Agency (FEMA) flooding special hazard zone map. The January 2009 flood event is described in the East Lents H&H Report as a 29-year event and is being utilized as the 25-year event for modeling purposes. The flood boundaries are delineated and presented in the East Lents H&H Report.

Table 1 shows a comparison of approximate acreages of the flooding observed during the January 2009 event and the acreage covered under FEMA's map of 100-year flooding special hazard zones.

Table 1 Areas flooded during the January 2009 flood event compared with areas under FEMA special hazard zones

Location	Land Use	2009 Flood Inundation Area (acres)	100-year FEMA Mapped Floodplain (acres)
Northeast of Beggars-Tick	Residential	11.0	62.1
Northwestern study area	Residential	8.6	71.8
North of Foster Road	Commercial and industry	46.2	49.7
Between Foster Road and Johnson Creek	Commercial and industry	13.6	8.1
Freeway Land Company site	Commercial and industry	10.8	6.4
Various locations within the study area	Johnson Creek, Parks, and City-acquired parcels for flood storage and wetlands	131.9	142.3
Total		222.1	340.4

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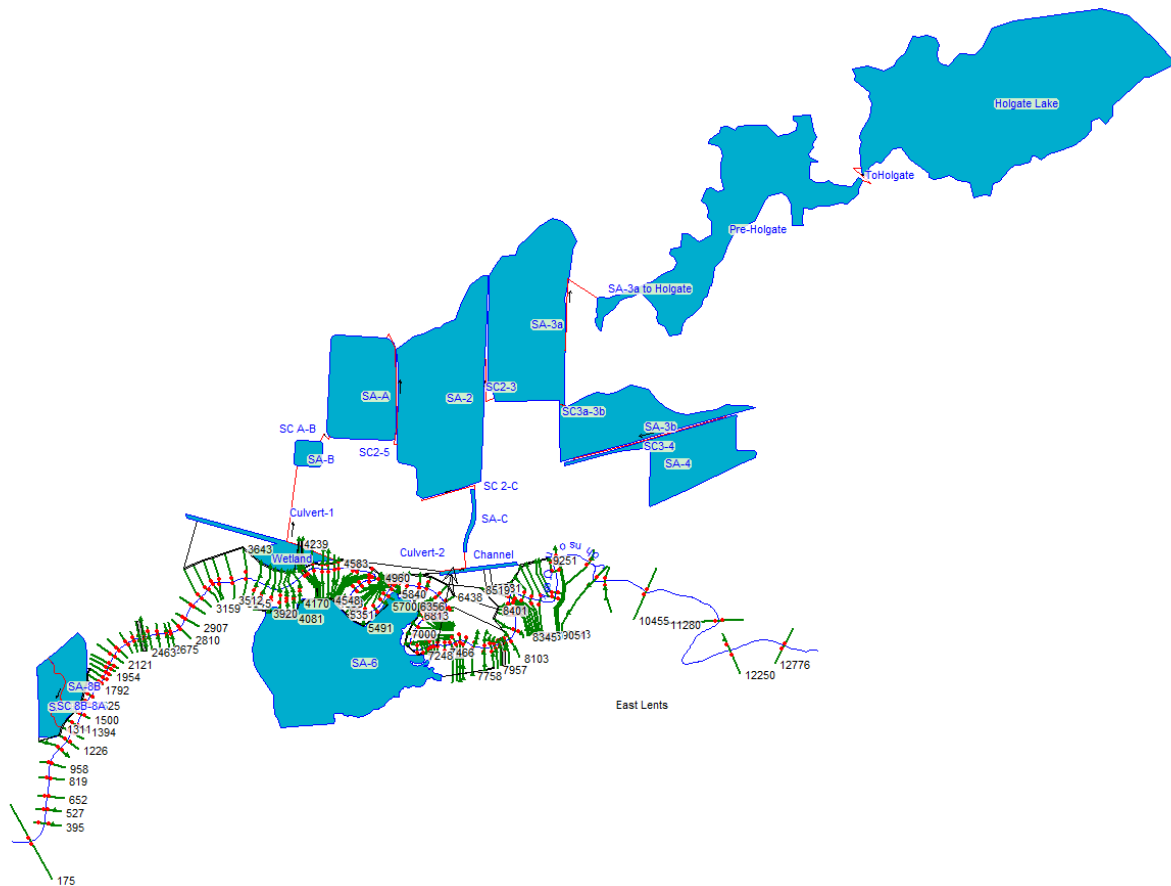
Potential Flood-Mitigation Improvements

By utilizing the HEC-RAS model previously developed for the East Lents project, Arup proposes a preliminary list of potential flood mitigation improvements for further consideration (see Appendix A for modifications made to the East Lents model). These improvements would reduce the frequency of flooding in the Foster corridor, by enhancing connectivity of the creek to the historic floodplain and wetlands to the north. These mitigations attempt to prioritize the parcels currently owned by the City for flood storage, mitigating flooding in the most valuable parcels adjacent to Foster Road (see Exhibit A):

1. Raise Foster Road by a maximum of 2ft between the 97th Avenue and 114th Avenue alignment.

2. Raise an 800-foot segment of Springwater Corridor Trail by up to 1ft between 108th Avenue and 111th Avenue.

3. Construct a new flood-retention basin (SA-A) adjacent to the western edge of Beggars-Tick Park and extending to the 105th Avenue alignment between Ellis Street to Yukon Street to provide 55 acre-feet (ac-ft) of flood storage.

4. Construct a new 4-acre-foot detention basin (SA-B) at the southwest block of the new retention basin (SA-A) and connect it to retention basin SA-A.

5. Construct two channels approximately 8 to 12ft in bottom width and 4ft deep along the south side of Foster Road. One will be 1,500ft long and extend from 101st Avenue to 106th Avenue, and the other will be 1,200ft long and extend from 500ft west of 111th Avenue to 700ft east of 111th Avenue. The two channels will intercept sheet flow toward the roadway, which may also serve as a hydraulic connection within the floodplain south of Foster Road.

6. Construct cross culverts at two locations to convey the flow intercepted in the channel along the south side of Foster Road to the proposed flood storage areas north of Foster Road, as follows:

    a. At the intersection of Foster Road and Springwater Corridor Trail: approximate culvert dimensions — two 8-by-4-foot barrels, 750ft long, to discharge 135 cubic feet per second (cfs) peak flow to basin SA-B, with a headwater not to exceed the edge of the pavement elevation of Foster Road.

    b. On the west side of 111th Avenue: approximate culvert dimensions — 6-by-4-foot concrete box culvert, 140ft long, to pass 190cfs peak flow, with a headwater not to exceed the edge of the pavement elevation of Foster Road.

    These culverts should be designed to discharge return flow from the storage area back to Johnson Creek after the peak. Additional cross culverts and hydraulic connect channels could be proposed during a more detailed final design.

7. Increase the overbank elevation by several feet along the western boundary of the Freeway Land Company site south of Johnson Creek.

8. Construct a linear basin/channel (SA-C), 20ft in bottom width and 4ft in depth, along the west side of 111th Avenue to connect the floodplain south of Foster Road and Beggars-Tick Park (SA-2).

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The following improvements are included in the HEC-RAS model, as they are currently being constructed as part of the East Lents Phase 2 project:

1. Regrade existing SA-6 to obtain 70.5ac-ft of additional storage.

2. Improve Johnson Creek, including removing the 72-inch-diameter bypass culvert and increasing the creek's channel and overbank as follows:

   a. Stations 4584–5200: widen the channel and overbank by up to 150ft

   b. Stations 5119–5491: widen the channel by up to 12ft

   c. Stations 6048–6536: widen the channel and overbank by up to 70ft

   d. Stations 6494–7522: widen the channel and overbank by up to 45ft

   e. Stations 7614–7957: widen the channel and overbank by up to 90ft

   f. Stations 8680–9252: widen the channel, overbank, and wetland by up to 170ft

Figure 2 Flood storage areas — proposed condition

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Potential Benefits to Communities

100-Year Flood Event

Should all of the above improvements be implemented, the preliminary HEC-RAS model indicates that the following benefits could be realized for the 100-year event:

1. Foster Road would not flood.

2. The Freeway Land Company site south of Johnson Creek would not flood (SA-9).

3. The majority of the wedge between Springwater Corridor Trail and Foster Road from the trail/road intersection to SE 111th Avenue (SA-1a and SA-1b) would not flood.

4. The large residential area north of Foster Road between I-205 and 104th Avenue (SA-7) would not flood.

5. The other areas north of Foster Road listed in **Table** 1, which are not used or proposed as flood storage would not flood.

6. The total flood volume being directed toward Holgate Lake would reduce from 93.5ac-ft to 65ac-ft.

For the proposed improvements, the peak flow at the most downstream cross section (River Station 175), which is about 80ft upstream of I-205, will not exceed the existing condition. The total volume discharged downstream of the study area during the three-day modeling period would reduce from 7,596ac-ft to 7,474ac-ft.

Table 2 Comparison of the peak discharges to downstream

River Station 175	Peak Flow Rate (cfs)	Three-Day Accumulated Volume (ac-ft)
Existing Condition	3,033	7,596
Proposed Base Scenario	3,003	7,474

25-Year Flood Event

The benefits realized during the 25-year flood event will be similar to those realized during the 100-year flood event. The 25-year flood event will utilize smaller storage volume than a 100-year flood event. During a 25-year flood, basin SA-8b would not be used for either the existing or proposed conditions.

Raising the elevation of Foster Road by approximately 0.5ft would alleviate flooding on the road during the 25-year flood event. Should the 25-year event be selected as the design event, it is likely that the culvert sizes proposed for the 100-year event would still be required, to prevent downstream peak flows from exceeding existing conditions under a 100-year event.

Preliminary Flood Storage Sensitivity Analysis

We request that BES and the City confirm whether each improvement described above is politically feasible and worthy of continued consideration. Upon confirmation of the feasible

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improvements, Arup will conduct a sensitivity analysis that summarizes the potential flood-reduction benefit and the order-of-magnitude cost for each potential improvement.

We have conducted a brief preliminary sensitivity analysis to verify the behavior of the model. As would be expected, reducing the proposed storage in SA-6 by 20ac-ft slightly increases the proposed downstream peak flow (3cfs) and total volume (19ac-ft) released downstream during the three-day modeling period.

Assumptions

This preliminary analysis is based on the following assumptions:

1. The potential improvements are based on the existing elevations obtained from the LiDAR_bare_Earth_Points GIS data obtained from the City.

2. The properties immediately adjacent to Foster Road are considered to have the highest potential development value and should be prioritized for removal from the floodplain.

3. The existing condition HEC-RAS model is based on the existing condition model developed for the East Lents Phase 2 Project, obtained from the City, and modified to include Holgate Lake and the hydraulic connection to the lake.

4. The datum used in the HEC-RAS geometry is City of Portland Datum, which is 2.1ft lower than the datum of the LiDAR_bare_Earth_Points GIS data, which is NAVD88 (Geoid 03).

5. The recorded January 2, 2009, flood had a peak discharge of 2,590cfs and is used to represent the 25-year event to be consistent with the East Lents Project.

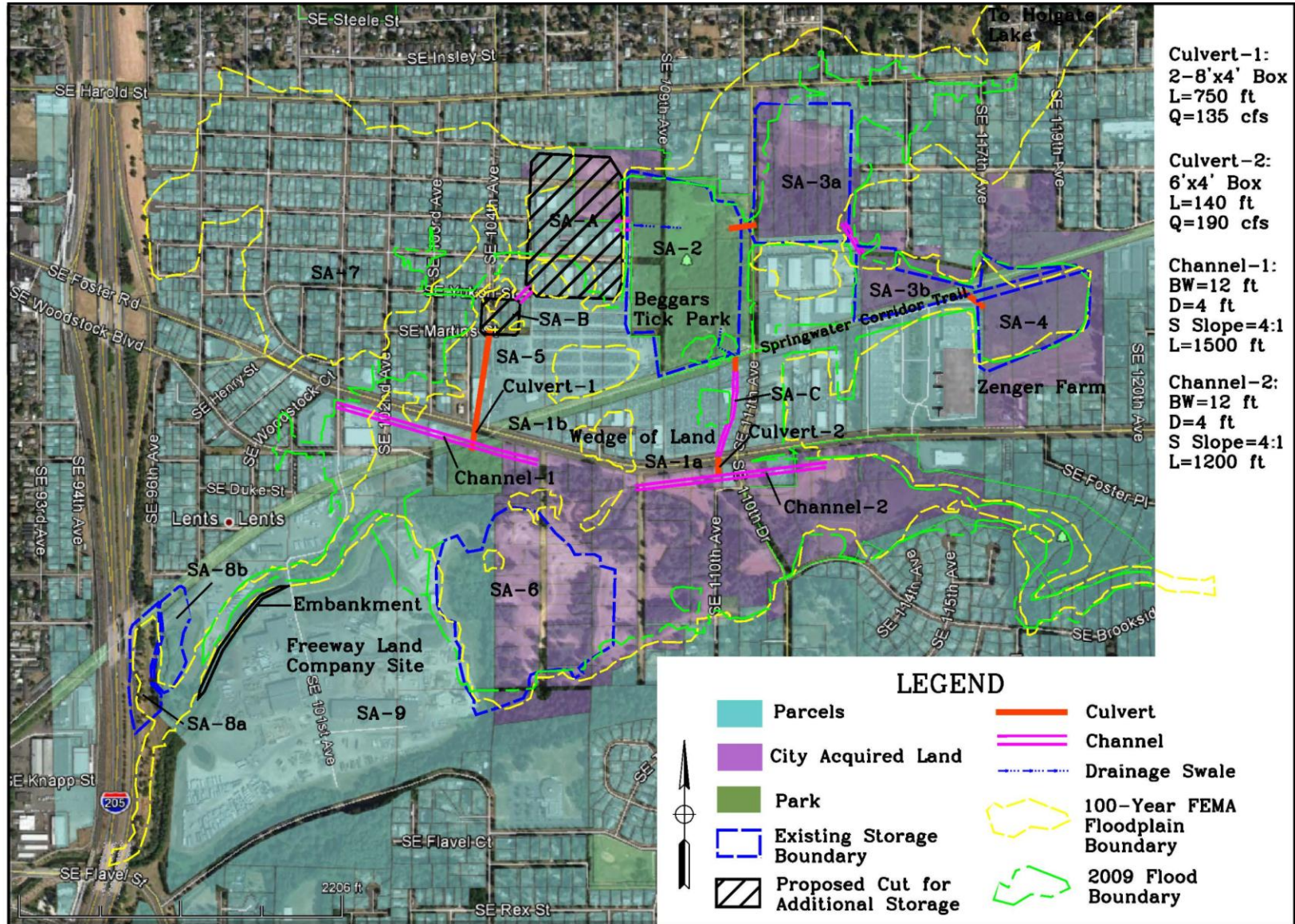J:\S-F\220000\224981-00\4 INTERNAL PROJECT DATA\4-05 REPORTS & NARRATIVES\FLOOD MITIGATION\MEMO_ARUP_PRELIMINARY HH MEMO_TASK 4_UPDATE_09132012_ISSUE TO PUTTMAN.DOCX

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Culvert-1:
2-8'x4' Box
L=750 ft
Q=135 cfs

Culvert-2:
6'x4' Box
L=140 ft
Q=190 cfs

Channel-1:
BW=12 ft
D=4 ft
S Slope=4:1
L=1500 ft

Channel-2:
BW=12 ft
D=4 ft
S Slope=4:1
L=1200 ft

LEGEND

- Parcels
- City Acquired Land
- Park
- Existing Storage Boundary
- Proposed Cut for Additional Storage
- Culvert
- Channel
- Drainage Swale
- 100-Year FEMA Floodplain Boundary
- 2009 Flood Boundary

Exhibit A Proposed improvements, FEMA 100-year floodplain and January 2009 flood boundary

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Appendix A

HEC-RAS Model Modifications

A1 Existing Condition HEC-RAS Model

Arup has established the existing condition HEC-RAS model through modify the existing condition model received from the City on May 11, 2012, (EastLentsP2.prj) and updated on July 9, 2012. The modifications to the existing condition model are as follows:

1. Limit the basin initial water surface elevations to no higher than the estimated groundwater surface elevations.

   We estimated groundwater elevations based on the information received from the City and limited the storage area initial water surface elevation to no higher than the groundwater surface elevation. The following storage area initial elevations were revised:

   a. SA-3b: initial elevation was changed from 204.00 to 207.30

   b. SA-4: initial elevation was changed from 204.21 to 207.80

   c. SA-8a: initial elevation was changed from 195.00 to 201.00

   d. SA-3b: initial elevation was changed from 196.00 to 201.00

2. Include storage at Holgate Lake and at the storage area within SA-3a to Holgate Lake.

   We have established elevation and storage volume relationship for these two storage areas based on LiDAR point data received from the City and converted from the NAVD 88 datum to COP Datum by lowering the elevation 2.1ft. The existing condition HEC-RAS model is modified to include two storage areas: Pre-Holgate and Holgate Lake. We also set up the hydraulic connection between these two areas based on the LiDAR point data.

Table 1 shows the maximum storage volume changes under the 100-year flood. The results show that, with the modifications, less flow could be stored within the existing storage areas — SA-3b, SA-4, SA-8a, and SA-8b — and more flow would be sheet flow toward the Holgate Lake areas.

Table 1 Maximum storage volume changes under 100-year-flood

	Original Model	Modified Model
Storage Area	Storage Area Volume (acre feet)	Storage Area Volume (acre feet)
SA-3b	17.02	11.42
SA-4	20.44	15.71
SA-8a	7.05	4.32
SA-8b	10.4	5.48
Holgate-1	92.6	84.1
Holgate Lake		9.4

A2 Proposed Condition HEC-RAS Model

The HEC-RAS model for the proposed condition was developed based on the final HEC-RAS model developed for the Phase 2 condition of the East Lents project and provided by the City on July 9, 2012. Except for the same modifications performed for the existing condition model, this

model was modified to incorporate the proposed improvements discussed in the Foster Lents Investment Corridor - Preliminary H&H Analysis Memo.

The modifications from the East Lents project Phase 2 model include the following:

1. Made the modifications discussed previously regarding the existing condition model.

2. Removed the storage area that covered the residential area north of Foster Road between I-205 and 104th Avenue (SA-7), and the associated hydraulic connections.

3. Removed the storage areas adjacent to Foster Road on the north side (SA-1a, SA-1b, SA-5) and the associated hydraulic connections.

4. Removed the storage area that covered the Freeway Land Company site south of Johnson Creek (SA-9) and the associated hydraulic connections.

5. Added a flood storage basin adjacent to Beggars-Tick Park on the left (SA-A), with a peak flood storage volume of 55ac-ft.

6. Added hydraulic connection between Basin SA-A and Beggars-Tick Park (SA-2), which simulates a spillway between Basin SA-A and SA-2.

7. Added a small detention basin (SA-B) with a hydraulic connection to SA-A.

8. Added two small storage areas (Wetland and Channel) south of Foster Road to simulate an existing wetland and two channel segments proposed south of Foster Road.

9. Added a hydraulic connection from the two channel segments south of Foster Road to the flood storage areas north of Foster Road with Weir Embankment to simulate Foster Road embankment.

10. Proposed two culverts to cross Foster Road and simulated in the HEC-RAS model with two culverts crossing the Weir Embankment mentioned in item 7.