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CHAPTER 1: INTRODUCTION

Background

This concept study is focused on the SW 105th Avenue, SW Blake Street, and SW 108th Avenue corridor in the City of Tualatin, Oregon. This set of streets is referred to within the concept study as the Garden Corner Curves Corridor. A map identifying the streets within the corridor and the location within Tualatin is shown on the following page in Figure 1.1: Vicinity Map.

The Garden Corner Curves Corridor is a narrow, constrained roadway consisting of streets classified as minor and major collectors. These streets currently do not meet the City's standard for these road classifications. The corridor provides one of the few continuous north-south routes within the City, and also serves as a bridge between the two adjacent residential neighborhoods – Ibach and Midwest.

In the past, and recently, City staff and the public have expressed concerns about safety within the corridor, as well as the lack of facilities for pedestrians and cyclists.

The City's 2014 Transportation System Plan Update (TSP) identified a project to improve the corridor - Project ID R7 - with a short-term priority (within 5 years). This project would upgrade the corridor roadways to the City’s standard cross-section for the road classification, and was estimated to cost $5,086,000 in 2012. Project R7 was ranked relatively high in priority within the TSP, but the high cost and the limited available funding presented challenges to constructing this project. Any proposed improvements to the corridor will be challenging due the limited available Right-of-way, as well as the existing steep topography and the presence of environmentally-sensitive lands throughout the corridor.

The City recognized that improving the corridor to full width as defined in the TSP would be difficult. In order to move forward with improving the corridor while recognizing the difficulties in reconstructing the corridor roadways to the City’s standard, the City added a concept study of the project to their 2016-2020 Capital Improvements Plan. In August 2016, Wallis Engineering and Alta Planning & Design were retained by the City to complete the concept study.

Study Goal

The goal of this project is to develop conceptual solutions that balance cost, safety for all users, stakeholder desires, environmental impacts, and right-of-way impacts. This goal will be achieved by the following process:

- Identify deficiencies within the corridor based on a strong and ongoing public outreach effort, City needs, and applying engineering judgement
- Develop solutions to these deficiencies in the form of conceptual design alternatives for the corridor, continually refined by input from the public, stakeholders, and City staff
- Evaluate each design alternative according to anticipated impact on environmental permitting, fish passage, utilities, lighting, stormwater and drainage, safety, and overall project cost.
- Assist in selection of a preferred alternative by communicating relative impacts and costs to the public and the City
- Provide an implementation plan which outlines the best path forward to make the project a reality.
Organization of this Document
This study is divided into a total of five chapters. A brief description of each chapter (with the exception of this chapter) is included in the following paragraphs.

Chapter 2: Existing Conditions
This chapter describes the character and land use within the corridor, discusses surface conditions such as topography and environmentally sensitive areas, and summarizes the existing transportation facilities within the corridor. A brief summary of the existing utilities throughout the corridor is also included.

Chapter 3: Design Development
The development of design alternatives in conjunction with an extensive public involvement effort is described in Chapter 4. This chapter also summarizes the results of the public involvement efforts and the determination of the preferred alternative.

Chapter 4: Evaluation of Design Alternatives
This chapter evaluates the design alternatives described in Chapter 3 according to their impacts on existing constraints and conditions, associated cost of implementation, and other impacts.

Chapter 5: Implementation Plan
This chapter describes how the preferred design alternative might be implemented, including a discussion of phasing and potential funding sources.
CHAPTER 2: EXISTING CONDITIONS

Introduction
This chapter summarizes existing conditions within the corridor. A discussion of these conditions includes the character of the corridor and surrounding land uses, transportation facilities for each mode of travel, existing streetscape elements, and public and private utilities.

Character and Land Use
The general character of the corridor is that of a narrow and constrained rural road which is experiencing increased use as the surrounding areas develop. Land use through the corridor is predominantly residential, but as one of the few north-south collector routes, the corridor carries a significant amount of thru traffic. The corridor is signed “No Trucks”, but truck traffic is sufficiently frequent to be noted by the public and City staff.

Figure 2.1 on the following page illustrates the existing land use within the corridor. The corridor roadways are owned and maintained by the City of Tualatin. A portion of the corridor is located outside the city limits of Tualatin, and is zoned by Washington County. The corridor study area includes some land which is zoned light and heavy industrial, but these parcels do not have a direct roadway connection onto the corridor.

The Garden Corner nursery is the only commercial property along the corridor, located at the southeast corner of SW 108th Avenue and SW Blake Street. This nursery is viewed by the area neighborhoods as a positive asset to the community. Ibach Park borders the corridor, but has no direct connection to the roadways except for an informal trail from SW 105th Avenue down to the undeveloped portion of the park.

Topography and Environmentally Sensitive Areas
Existing conditions within the corridor include steep topography and environmentally-sensitive areas. A graphic illustrating these conditions within the corridor is included as Figure 2.2 on the following page.

In general, the corridor slopes downwards from SW 108th Avenue toward SW 105th Avenue. SW 108th Avenue has relatively gentle to moderate slopes. SW Blake Street and SW 105th Avenue include moderate to steep slopes associated with the presence of Hedges Creek. Hedges Creek passes through the corridor at SW 105th Avenue, north of that street’s intersection with SW Blake Street. The topography surrounding Hedges Creek is particularly steep.

The corridor width is constrained, with a narrow pavement width surrounded by heavy vegetation, and in many areas, steep topography. For the most part, stormwater runoff from the road either collects in ditches, or runs off onto vegetated slopes.
Figure 2.1: Existing Land Use

City of Tualatin
Garden Corner Curves Corridor Study
Figure 2.2: Existing Topography
City of Tualatin
Garden Corner Curves Corridor Study
Erosion due to stormwater runoff occurs at several locations through the corridor, most notably at the southeast corner of SW 108th Ave and SW Blake Street, and the northwest corner of SW Blake Street and SW 105th Ave. Most stormwater on SW 108th Avenue is collected by stormwater inlets, which convey runoff to stormwater mains on adjacent streets.

As shown on Figure 2.2, the corridor is located within environmentally-sensitive areas associated with Hedges Creek, including wetlands and areas classified as Water Quality Sensitive Areas by Clean Water Services (CWS). CWS also identifies a Vegetated Corridor around the creek, which is protected from development and requires restoration if disturbed. The City’s Natural Resource Inventory and Local Wetlands Inventory also identify wetlands and forest resources within the corridor.

A preliminary wetland determination was conducted by Campbell Environmental as part of this concept study. Based on this determination, one wetland was identified within the project study area along the east side of SW 105th Avenue, associated with the roadside ditch draining south from SW Paulina Drive into Hedges Creek. A memorandum discussing the determination and summarizing environmental permitting issues for the project is included in Appendix A.

Hedges Creek passes under SW 105th Avenue through a 42-inch corrugated metal pipe culvert with a rockery headwall. Modeling by Clean Water Services (CWS) indicates that this culvert has inadequate capacity, and the City has indicated that there are flooding issues associated with this area. Additional Hydraulic and hydrological modeling of this portion of Hedges Creek was performed as part of the corridor study in order to ascertain the capacity of the culvert and the potential need to replace the culvert. The results of this modeling and recommendations for replacement are summarized in a memorandum included in Appendix B. This memorandum confirms CWS conclusions that the existing culvert is undersized for hydraulic conditions.

It is possible that the existing culvert on Hedges Creek at SW 105th Avenue and SW Blake Street has components which were constructed during by the Works Progress Administration (WPA), during the Great Depression (circa 1935 to 1943). This is an unverified observation based on verbal histories and the appearance of the rockery wall surrounding the culvert.

The Oregon Department of Fish and Wildlife (ODFW) classifies Hedges Creek as a native migratory fish stream - habitat for species present on the Endangered Species Act (ESA) list. According to ODFW, native migratory fish do not appear to be able to reach this area of the basin. However, because the area was historically used by native migratory fish, and these fish may be present downstream of the corridor, fish passage must be addressed during design and construction. Aside from hydraulic considerations, ODFW has specific requirements for culverts, and the existing culvert at SW 105th Ave does not meet these requirements. According to the correspondence summarized in Appendix A, ODFW recommends addressing fish passage by either exemption, waiver and mitigation, or...
replacement of the culvert to meet fish passage criteria. ODFW also recommends replacing the culvert for hydraulic considerations.

**Existing Transportation Facilities**

The Garden Corner Curves Corridor provides transportation facilities for vehicular traffic. However, facilities for non-vehicular users are largely absent within the corridor, requiring bicyclist and pedestrian traffic to share the roadway with vehicles. **Figure 2.3** on the following page illustrates the existing transportation facilities within the corridor. The corridor roadways do not meet City road classification standards, and presents safety concerns for all users.

**General Roadway Characteristics**

The corridor is significant as part of a parallel route to the City’s key major arterial, SW Boones Ferry Road, and as a connection to SW Grahams Ferry Road. In addition, the corridor is particularly accessible for vehicles, with no signals or stop signs regulating flow. Though the corridor is appealing to thru traffic, these roadways are located within predominantly residential neighborhoods.

The City of Tualatin classifies SW 105th Avenue as a Major Collector. SW Blake Street and SW 108th Avenue are classified as Minor Collectors. The minimum facilities for these roadways according to their classification are included below as **Table 2.1**, as well as the actual facilities.

**Table 2.1: Classified and Actual Street Facilities**

<table>
<thead>
<tr>
<th></th>
<th>SW 105th Avenue</th>
<th>SW Blake Street</th>
<th>SW 108th Avenue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Street Classification</strong></td>
<td>Major Collector</td>
<td>Minor Collector</td>
<td></td>
</tr>
<tr>
<td><strong>Minimum ROW per Classification</strong></td>
<td>54-ft wide</td>
<td>62-ft wide</td>
<td></td>
</tr>
<tr>
<td><strong>Actual ROW</strong></td>
<td>60-ft wide</td>
<td>40-ft wide</td>
<td>50-ft wide</td>
</tr>
<tr>
<td><strong>Minimum Facilities per Classification</strong></td>
<td>(2) 11’ travel lanes 5’ bike lane on each side of road 6’ planter strip on each side 5’ sidewalk on each side</td>
<td>(2) 11’ travel lanes 5’ bike lane on each side of road 8’ parking strip on one side of road 6’ planter strip on each side 5’ sidewalk on each side</td>
<td></td>
</tr>
<tr>
<td><strong>Actual Facilities</strong></td>
<td>(2) 10’ travel lanes</td>
<td>(2) 10’ travel lanes</td>
<td>(2) 10’ travel lanes 6’ planter strip on west side 5’ sidewalk on west side</td>
</tr>
</tbody>
</table>

*Per City classification for both major and minor collectors, a 12’ multi-use path may be substituted for sidewalk and bicycle lane, but a planter strip must be installed between travel lane and multi-use path.

As described above in **Table 2.1**, the existing roadways typically consist of two, ten-foot wide travel lanes. There are no separated facilities for pedestrians or bicyclists, and the shoulder of the road is rarely wider than a foot.
Figure 2.3: Existing Transportation Facilities

City of Tualatin
Garden Corner Curves Corridor Study
Roadway Signage, Delineation, and Traffic Control

Traffic control signals, signage, and delineation are limited throughout the corridor. The existing road is striped with a double yellow centerline, and white shoulder lines. Existing signs include posted and advisory speed limit signs, a few chevron signs at corners, and a warning sign for deer. The visibility of some of these signs is limited, with some obscured by vegetation.

The only traffic control system within the corridor limits consists of a warning signal system intended to inform drivers that pedestrians or bicyclists may be within the corridor. This warning signal system does not appear to be fulfilling its intended function. A memorandum is included in Appendix C which describes the system, discusses observed deficiencies, and recommends improvements.

Connectivity

The corridor provides significant connectivity for vehicular thru-traffic, but connectivity to the surrounding residential neighborhoods is limited. There are relatively few intersecting streets throughout the corridor, given its length (see Figure 2.3 on the preceding page).

SW Moratoc Drive and SW Paulina Drive at the north end of the corridor, and SW Willow Street at the south end provide connections to the residential neighborhood on the east side of the corridor. Existing sidewalk connections are available at these intersecting streets, but no separated bicycle facilities. The sidewalk on SW 108th Ave provides sidewalk connection to the residential neighborhood on the west side of the corridor, with a bike lane that begins just prior to the corridor, at SW Neirman Lane.

An informal trail connection to Ibach Park exists to the south of the intersection of SW 108th Avenue. A planned trail connection – the Helenius Greenway – is intended at the west terminus of SW Blake Street.

Safety Issues

Safety is a frequently cited concern by the public and by City staff. Safety issues within the corridor include limited sight distance, poor lighting, vehicular speeding, poor signage, substandard roadway geometry, and the absence of facilities for pedestrians and bicyclists. Crash history through the corridor is limited, but supports safety concerns. All available crash history obtained from the Oregon Department of Transportation between January 2011 and December 2015 shows a total of three crashes within the corridor. In addition to these documented crash incidents, at least three undocumented incidents have occurred at the intersection of SW 108th Ave and SW Blake St.
There are relatively few intersecting streets throughout the corridor. As assessed according to AASHTO and the City’s Public Works Construction Code, some of these intersections do not meet existing standards. The intersection of SW Blake St & SW 105th Ave consists of a pair of broken back curves and steep slopes, as well as a cut bank on the inside of the curve. As a result, vehicles have limited sight distance, and larger vehicles have difficulty making safe turning movements. The intersection of SW Blake St & SW 108th Ave has a substandard radius, limited space for large vehicular turning movements, and inadequate sight distance. Both intersections are also frequently perceived by the public as having safety issues.

The corridor roadways are constrained, with a limited paved width and heavy vegetation and trees on either side. Street lighting is limited to cobra head luminaires mounted to overhead utility poles, which are widely spaced. The limited sight distance coupled with inadequate lighting present safety concerns throughout the corridor.

Speeding has been cited as a safety concern by the public. The posted speed limit is 30 mph through the corridor, with advisory speed limits of 10 and 15 mph around the corridor corners. In order to determine if speed was indeed an issue of concern, the City collected hourly speed data through the corridor at two locations for a period of nine consecutive days in the fall of 2016. Data was collected for northbound and southbound travel lanes by a radar speed counter placed on the east side of SW 105th Avenue, just north of this street’s intersection of SW Blake Street. The data from this counter indicates that the majority of vehicles travelling through the corridor through this period were in excess of the posted speed limit. While this sample was not an official speed survey, and represents a brief snapshot of conditions within the corridor, it does indicate that speeding is likely a problem through the corridor.

The corridor functions both as a thru-traffic route for vehicular traffic, and as the only direct route for bicyclists and pedestrians within the surrounding neighborhoods. This dual use results in potential conflicts and safety concerns for pedestrians and bicyclists, who have no designated or separated facility from the vehicular travel lanes, and extremely limited shoulders throughout the corridor.
**Existing Utilities**

There are several public and private utilities located within the corridor. The approximate location of these utilities is shown in the attached **Figure 2.4**.

The City of Tualatin owns and maintains some water, sewer, and stormwater system components within the corridor roadways. Clean Water Services owns some subsurface sewer mains adjacent to and within the corridor roadways.

A gas main owned and maintained by NW Natural is located under the roadway throughout the corridor. Overhead power and other utilities are located on utility poles along the corridor roadway.
Figure 2.4: Existing Utilities

City of Tualatin
Garden Corner Curves Corridor Study
CHAPTER 3: DESIGN DEVELOPMENT

Introduction
This chapter describes how the project team arrived at design solutions for the corridor. The intent of this concept study was to conduct extensive public outreach and engagement in order to arrive at a solution that would address public concerns and desires as thoroughly as possible.

As discussed in Chapter 1, the City’s Transportation System Plan (TSP) identified a project to improve the corridor, which would upgrade the corridor roadways to the City’s standard cross-section for the road classification. Though the TSP project was ranked relatively high in priority, it had a high cost and presented considerable difficulties in the face of funding shortfalls, extensive environmental permitting, and the need to acquire private property to construct these improvements. Development of design solutions focused on providing options which might be more readily implemented, and with a solid base of public and private stakeholder approval.

The development of a conceptual design followed a process which could be roughly divided into the following five phases:

- Listening Phase
- Schematic Design Development
- Presentation and Refinement of Schematic Designs
- Finalizing Design Concepts
- Presentation of Preferred Alternative and Corridor Study Report

A description of the goal, process, and results of each of these phases is included in the following paragraphs.

Listening Phase
The goal of the listening phase of the project was to determine the public and stakeholder concerns, desires, and goals for the corridor.

The City and the design team recognized that this project should be led by the people who wanted to see improvements to the corridor the most – the public and key stakeholders. During this phase, the project team provided information about the existing conditions throughout the corridor and pointed out specific challenges.

Listening Phase Process
Methods of reaching out to the public during this phase included general outreach tools such as website posts, targeted stakeholder outreach including multiple meetings, and public and online events, including a corridor site tour and online survey. A detailed summary of the public engagement effort is included as a memorandum in Appendix D.
Results of the Listening Phase

Improving the corridor’s neighborhood connectivity was a major driver of the concept study. Therefore, it came as no surprise that the vast majority of input during the listening phase of the project came from people living in a neighborhood adjacent to the corridor. Safety was the most common concern expressed during this phase of the public outreach process. Common safety concerns throughout this phase included the following:

- Speeding
- Lack of bicyclist and pedestrian facilities
- Constrained lane widths
- Limited visibility
- Limited sight distance

At this phase, design solutions were not offered by the design team. Stakeholders and the public were asked what their concerns and priorities were for the corridor. The most common items that the public and interested stakeholders desired to see included:

- Safety improvements for all users
- Safe access for bicyclists and pedestrians
- Connectivity to surrounding neighborhoods
- Lighting, visibility and sight distance improvements

A more detailed description of input during the listening phase is included in the memorandum in Appendix D.

Based on the input received from the listening phase, the consultant team developed schematic designs.

Schematic Design Development

The public outreach effort during the listening phase gave the design team a robust sense of the deficiencies and desires for the corridor. The goal of schematic design development was to develop at least three schematic solutions for the corridor that addressed the issues raised during the public outreach effort as fully as possible.

Process of Developing Schematic Designs

Public and stakeholder guidance was relatively consistent, with the vast majority of people expressing interest in safety, access, connectivity, and lighting improvements to the corridor. This guidance was the framework for developing solutions, with engineering judgement providing a number of potential design options.

In addition to public guidance and engineering judgement, there were a number of other factors which influenced the development of schematic design options.
**Private Property Impacts**

Based on strong public opinion and City requests, design development sought to minimize impacts to private property where possible. This included minimizing the need to purchase right-of-way to construct corridor improvements.

Minimizing right-of-way acquisition had the benefit of reducing project costs – less property to purchase, and less available right-of-way to construct improvements (thus less improvement width). However, the disadvantage of limiting right-of-way was that the road could not be reconstructed to current standards, both for typical roadway design standards codified in AASHTO, and to the City’s street classification for minor and major collectors.

**Environmental Impacts**

As discussed in Chapter 2, the corridor passes through environmentally-sensitive areas. Construction within a wetland or a riparian habitat qualifies as an adverse impact to these areas. Not only are there costs associated with completing environmental permitting when work is done within environmentally-sensitive areas, there are additional costs associated with mitigation. For example, destruction of a wetland to construct a sidewalk requires construction of wetland habitat elsewhere (mitigation).

In the course of developing design solutions, solutions were sought that minimized adverse impacts to environmentally-sensitive areas where possible. This was done at the City’s direction, and in order to minimize associated costs.

**Cost Implications**

Reconstruction of the Garden Corner Curves corridor to meet City standards was identified as a project in the City’s Transportation System Plan, at an estimated cost of $5.1 million (in year 2014 costs). Constructing this project would be expensive, and presented other challenges such as limited funding, challenging environmental permitting, and extensive right-of-way acquisition. The City desired to explore other alternatives for improving the corridor, at more manageable costs.

Minimizing costs was a factor in developing design solutions. All four of the design options provide a continuous access route for pedestrians, bicyclists, and vehicles through the corridor, thus addressing access concerns. In addition, the design options make improvements to the road which would improve safety for all users. Though a concept study provides a conceptual – rather than detailed – design, the relative cost implications of design options could be determined and used to help make decisions.

**Results of Schematic Design Development**

Four schematic design solutions were developed by the project team. Detailed graphics illustrating each option are included as Appendix E. These graphics were included on the project website, as well as being presented at the Public Open House and City Council Meeting.

All of these solutions provided a continuous route for pedestrians and bicyclists through the corridor, as well as making safety and lighting improvements for all users. For all of the options, vehicular travel lanes would not change in width, though improvements to geometry would be made to improve safety. The solutions are estimated to be relatively similar in cost, ranging from 3.1 to 3.7 million.
A short summary of each solution is included in the following paragraphs.

**Option A: East Shared Use Path**
This option would construct a 12-foot wide shared use path on the east side of the corridor roadways for use by bicyclists and pedestrians.

**Option B: West Shared Use Path**
This option would construct a 12-foot wide shared use path on the west side of the corridor roadways for use by bicyclists and pedestrians.

**Option C: Sidewalk and Bike Lanes**
This option would construct a 5-foot wide sidewalk on the east side of the corridor roadways for use by pedestrians, and buffered bike lanes on both sides of the road for bicyclists. SW 108th Avenue currently has sidewalk on the west side of the street – with the addition of sidewalk to the east, this is the only portion of the corridor which would have sidewalk on both sides of the road.

**Option D: Sidewalk and Bike Lanes – Both Sides**
This option would construct a 5-foot wide sidewalk on both sides of the corridor roadways for use by pedestrians, and buffered bike lanes on both sides of the road for bicyclists.

**Interchangeable Design Elements for All Options**
There are a number of potential improvements to the corridor in addition to adding bicyclists and pedestrian facilities to the corridor. All of these interchangeable design elements may be applied to any of the four schematic design options described in the previous paragraphs. Such design elements include the following:

- Crossing improvements at SW Moratoc Dr and SW 105th Ave
- Crossing improvements at SW Paulina Dr and SW 105th Ave
- Intersection improvements at SW 105th Ave and SW Blake St
  - Revised geometry (spiral-curve-spiral) to improve sight distance and safety
  - Stormwater facility or landscaping buffer between vehicles and pedestrians/bicyclists
- Intersection improvements at SW 108th Ave and SW Blake St
  - Raised crosswalk
  - Concrete speed table with crosswalk
  - RRFB
  - Stop sign
  - Landscaping strip to separate vehicles from pedestrians/bicyclists
- Crossing improvements at SW Willow St and SW 108th Ave
- For shared-use paths:
  - Pavement marking to separate pedestrian and bicycle travel at road corners
  - Painted pavement transitions where shared use path ends and onstreet bike lane starts
- Safety and speed reduction strategies
  - Speed feedback sign
It should be noted that these interchangeable design solutions were assumed for all four schematic design options. However, specific and detailed design of these solutions would be completed as project design progresses beyond the conceptual stage. The inclusion of one or the other of these solutions does not substantially change the overall conceptual design for the corridor. For example, adding a raised crosswalk instead of a concrete speed table at SW 108th Ave and SW Blake St will not substantially change the conceptual design of the corridor – both options provide a crossing option for bicyclists and pedestrians at this location. Ultimately, this concept study will result in a conceptual design that will guide detailed design as the project progresses.

Interim Improvements
There are a number of interim improvements which could be implemented within the corridor in the short-term. These improvements could improve conditions within the corridor at considerably less cost than the design alternatives discussed. They could increase visibility, reduce motorist speeding, and improve overall safety through the corridor. It is important to note that these improvements would not provide continuous safe facilities for pedestrians and bicyclists. A technical memorandum discussing potential improvements was completed for the project, and is included as Appendix F.

One of these interim improvements would be to make improvements to the existing warning signal system within the corridor. A memorandum with specific recommendations is included as Appendix C.

Presentation and Refinement of Schematic Design
The schematic designs were presented to the public and interested stakeholders with the continuation of the public outreach and engagement effort. The goal of this presentation was to obtain specific, useful feedback in order to refine the schematic design solutions for the corridor. This feedback was also used to determine which, if any of these solutions, was preferred.

Process for Presentation and Refinement of Schematic Design
Each of the four schematic alternatives were evaluated according the anticipated impacts each might have on existing constraints within the corridor, as well as their estimated costs. This evaluation is included in Chapter 4 of the Concept Plan. This evaluation allowed the design team to provide additional information to the public and interested stakeholders during presentation of the schematic alternatives.

The schematic designs were presented on the project website, included in an online survey, and during a project open house. Reception of the designs was largely positive, and a wide variety of specific input was received. The public outreach and engagement memorandum included in Appendix D provides greater detail on the process and results of this effort.
Results of Presentation and Refinement of Schematic Design

Refining these design options resulted in four design alternatives. Schematic design option 1 became Design alternative A, and so forth. The input on schematic designs was largely positive, with some refinements.

The most common significant comments on the schematic design options include:

- Concerns about mixing bicyclist and pedestrian traffic
  - at the corner of SW 108th Ave and SW Blake St
  - for downhill traffic on the shared use path; suggestions that bicyclists can share the road
- Safety concerns about pedestrians and bicyclists crossing vehicular traffic at the corner of SW 108th Ave and SW Blake St
- Safety concerns about pedestrians and bicyclists crossing vehicular traffic on SW 105th Ave at SW Paulina Dr
- Overarching concern about speeding immediately prior to and exiting the corridor (i.e. requests for stop signs at SW Paulina Dr and SW 105th Ave)
- Speed humps were controversial, but raised crosswalks were perceived largely favorably
- Speed limit should be adjusted
- Option A preferred over the other options. Options A and B were most popular. Option D was by far the least popular option.

The refined design alternatives addressed these comments as much as possible, and the following modifications were made:

- A speed feedback sign is shown on SW Blake Street
- A yellow centerline will separate the vehicular travel lanes through the corridor
- A planter is shown on the corner of SW 108th Ave and SW Blake St
- The corner crossing at SW 108th Ave & SW Blake St is shown as a raised crossing, with the entire corner raised.

Selection of a Preferred Alternative

In order to select a preferred alternative, the estimated costs and impacts on existing constraints were evaluated, as described in Chapter 4 of this report. Based on that evaluation, it appears that there are not significant differences between the design alternatives, though Alternative D with the widest improvement width is clearly less favorable compared to the other alternatives. This is logical – costs and impacts are relatively proportional to the actual improvement width of a roadway, and the improvement widths for each alternative are relatively similar.

In addition to consideration of costs and impacts, the opinions and perceptions of the public, stakeholders, and City staff were also important factors in selecting a preferred alternative.

Based on public and stakeholder input the preferred alternative appeared to be Option A. City staff generally agreed that this alternative was preferable.
**Presenting the Preferred Alternative and Corridor Study Report**

The goal of this phase of work was to present the preferred alternative to City Council, the public, and stakeholders, with the ultimate goal of recommending this alternative to be implemented.

The Draft Corridor Study Report was presented to the public through the project website, and was sent directly to project stakeholders. On November 13, 2017, the preferred alternative was presented to City Council.
CHAPTER 4: EVALUATION OF DESIGN OPTIONS

Introduction
Four concept options were developed to address the perceived concerns within the Garden Corner Curves Corridor. This chapter discusses the impacts each option may have on existing constraints within the corridor. Anticipated impacts and the estimated cost of each option will be two of the decision criteria for selecting a preferred alternative.

Safety Evaluation
Safety is a subjective exercise. In other words, it is difficult to evaluate and compare safety – particularly for improvements which are not yet built.

In developing these design options, it is important to note that the design team focused on meeting three important safety considerations, including safety design standards, comfort level for all users, and minimizing potential conflict points. These are discussed briefly in the following paragraphs.

Safety Design Standards
Design development considered safety requirements according to accepted roadway design standards. These standards include roadway geometry, sight distance requirements, signage, and striping.

Where minimum accredited standards have not achievable without significantly adverse impacts to private property and environmentally-sensitive areas, mitigation methods to improve safety were evaluated to mitigate these deficiencies.

Comfort level for all users
The comfort level for all users was an important component in developing the safest possible design options. Driver comfort level was addressed by addressing roadway geometrical concerns as best as possible within the limited right-of-way, and by recommendations for lighting and other improvements. A number of pedestrian and bicyclist facilities are proposed in the four design options, including shared-use paths, sidewalks, and on-street buffered bike lanes. The comfort level for pedestrians and bicyclists varies between each of these facilities and the type of user, but overall, the goal of the design team was to maximize that comfort level. For example, bicyclists generally are more comfortable in a buffered bike lane than a bike lane with a single shoulder lane stripe.

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Potential conflict points are a typical safety metric for roadways. For example, an intersection where a pedestrian must cross the road in order to continue their travel route presents a potential conflict with a vehicle traveling in the road. Design solutions were developed in order to minimize the likelihood that modes of travel would have to cross at these points.
Environmental Permitting and Fish Passage Evaluation

There are a number of environmentally-sensitive areas with the project area, as discussed in Chapter 2. The presence of these areas has important implications on the process and cost of constructing improvements within the study corridor.

The proposed road improvements for all options would require construction to take place within areas that have been identified as wetland and riparian habitat. As such, this work would require completing a number of permitting processes, which are discussed in detail in Appendix A. These include the following:

- U.S. Army Corp of Engineers Section 404 Compliance
- Department of State Lands Removal/Fill Permit
- Oregon Department of Environmental Quality Section 401 Certification
- NMFS SLOPES V Programmatic Approval
- Oregon Department of Fish and Wildlife Fish Passage Approval
- Clean Water Services (CWS) Service Provider Letter

Completion of permit and approval processes from regulatory agencies would be relatively similar for the four design options.

In addition to permitting, the adverse effects of constructing each option on these environmentally-sensitive areas would require environmental mitigation. The extent—and cost—of environmental mitigation for each option varies; the greater the extent of improvements, the more mitigation required. In other words, Option D has the greatest mitigation requirements of all four options, due to its greater improvement width. Potential mitigation requirements for this project are described in detail within Appendix A. Some opportunities for meeting those requirements include:

- Expanding and enhancing onsite corridors
- Enhancing offsite resources

As discussed in Chapter 2, the existing culvert over Hedges Creek at SW 105th Avenue & SW Blake Street is hydraulically undersized and presents a barrier to native migratory fish. The existing culvert is narrower than the proposed improvement. In order to construct the road improvements above Hedges Creek, the culvert would have to be reconstructed. Reconstruction of the culvert triggers certain regulatory requirements for hydraulic capacity of Hedges Creek, and for fish passage through Hedges Creek. The extent of the culvert reconstruction will be largely determined by regulatory authorities, including the Army Corps of Engineers and the Oregon Department of Fish and Wildlife. Though the width of the culvert replacement would vary according to each design option’s improvement widths at this location, all four proposed options would trigger relatively similar requirements from these regulatory authorities.
A technical memorandum is included as Appendix B which proposes a conceptual culvert design that would meet hydraulic and fish passage requirements. The cost for conceptual culvert replacement would be relatively similar for all options.

**Stormwater Impacts and Mitigation Options**

Current stormwater drainage throughout the corridor largely consists of off-road dispersal, with some ditches, and a few catch basins. Improvement of the corridor would increase the impervious surface areas, and would require treatment of stormwater runoff according to standards set by both Clean Water Services (CWS) and the Army Corps of Engineers Standard Local Operating Procedures for Endangered Species (SLOPES V). Impervious surface in this case would be defined as pavement and sidewalk. The cost to construct stormwater improvements is directly proportional to the amount of impervious surface. In other words, the wider the improvement width, the greater the impervious surface, the more money necessary to design and construct stormwater improvements.

Stormwater improvements would consist of collection, conveyance, treatment, detention, and disposal of stormwater runoff. Treatment of stormwater improvements using Low Impact Development (LID) methodology would be a priority due to City preference and direction from CWS. LID treatment facilities designed according to CWS standards prioritize “green” solutions, such as bioswales. All the concept options include a LID stormwater treatment facility at the corner of SW Blake St and SW 105th Ave. Additional LID design solutions applicable to the corridor could include pervious pavement for sidewalks or shared use paths, vegetated filter strips and LIDA swales.

It should be noted that there are limitations on LID solutions for the corridor. There is limited available public right-of-way – which limits the available area for swales and other green solutions. In addition, the applicability of some green solutions for stormwater treatment is limited by steep slopes, limited surface area (due to limited available right-of-way), and likely non-infiltrating soils. As mentioned, stormwater design will likely need to be completed according to SLOPES V, which requires treatment of pre-developed flows. The quantities of stormwater runoff necessary for treatment per SLOPES V will be relatively large compared to other standards – with correspondingly higher costs. Stormwater treatment through LID methodology (green solutions) requires a relatively larger surface area and flatter slopes than other methods, such as mechanical treatment. Given the steep slopes and limited right-of-way, design of stormwater management facilities will probably include a combination of LID and other stormwater solutions in order to treat the stormwater runoff from these improvements.
These facilities would be relatively similar for all improvements, with the scope of work (and cost) proportional to the improvement width and impervious area.

**Right-of-Way Evaluation**

Public right-of-way throughout the corridor is limited, and each of the proposed options would require the purchase of some private property for construction of improvements. Purchase of private property in this context is referred to as right-of-way acquisition. In order to construct the proposed improvements on publicly-owned land, all of the options would require purchase of a “strip” of property adjacent to the road from two to three parcels. None of the design options would require the purchase of an entire property, or even a significant percentage of a property.

The approximate quantity of Right-of-way acquisition necessary to construct each option was estimated based on the City’s GIS mapping, and used for cost estimating purposes only. It is important to note that GIS is approximate, and these numbers may be used only for planning-level purposes. As this project moves forward, more accurate quantities for ROW purchase may be obtained with a survey of the area and more detailed engineering design.

A table with these estimated quantities is included below as Table 4.1.

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<tbody>
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<td>2</td>
<td>3,205 SF</td>
</tr>
<tr>
<td>Option 2</td>
<td>3</td>
<td>2,750 SF</td>
</tr>
<tr>
<td>Option 3</td>
<td>2</td>
<td>2,520 SF</td>
</tr>
<tr>
<td>Option 4</td>
<td>3</td>
<td>7,210 SF</td>
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As seen in the above table, right-of-way acquisition is relatively similar for Options 1 through 3, and considerably higher for Option 4.

**Utility Evaluation**

Corridor improvements associated with each option impact existing surface and subsurface utilities. The scope of these impacts is relatively similar throughout all options, and is described in the following paragraphs.

Impacts to the water system would be minimal for all options, with some potential for relocation of the existing fire hydrant at SW 108th Ave and SW Blake Street.

The stormwater conveyance system is relatively limited through the corridor, and as such, impacts to that system would also be limited. Existing stormwater inlets at the intersections of SW 105th Ave with SW Paulina Dr and SW Moratoc Dr would likely require replacement regardless of the design option, and a new outfall into Hedges Creek will be required due to reconstruction of the corner of SW Moratoc Dr and SW 105th Ave. Similarly, the existing stormwater inlet on SW 108th Ave south of SW Blake St will likely need to be replaced.
The sanitary sewer through the corridor would be impacted by the replacement of the culvert over Hedges Creek at SW 105th Ave. According to Clean Water Services mapping, there is a 14” sanitary sewer main within the road at this location. Replacement of the culvert would likely require replacement and/or relocation of this sewer main. Depending on the exact realignment of the road at the corner of SW 105th Ave and SW Blake St, some vertical adjustments might be necessary to the existing sanitary sewer manholes in the road at this location. All of these impacts would be relatively similar among the four design options.

As with the sanitary sewer, the subsurface natural gas system through the corridor would be impacted by the replacement of the culvert over Hedges Creek at SW 105th Ave. According to maps from NW Natural, there is a 4-inch gas main within the public right-of-way through the corridor. Replacement of the culvert would likely require replacement of this gas main. This main appears to have gas services to three properties along the corridor. Because gas services can be shallow, they might need to be replaced at a deeper location in order to construct the proposed corridor improvements. The scope of impacts to the gas system would be relatively similar among all options.

There are overhead power and cable/telephone lines mounted to utility poles within the shoulder throughout the corridor. Regardless of which option is implemented, the existing utility poles and the associated utilities would need to be relocated along the corridor in order to accommodate proposed improvements and to improve lighting.

**Lighting Evaluation**

Lighting improvements would be relatively similar in scope between all four options. Though each locate pedestrians and bicyclists in difference spaces within the road cross-section, all options locate both vehicular and non-vehicular traffic on both sides of the corridor roadways – and all these modes require lighting.

An evaluation of existing lighting was included in the scope of work for this project. Estimated costs for lighting improvements in each option were prepared in conjunction with this effort. The scope of illumination improvements would be similar for all the design options.

**Traffic Evaluation**

Anticipated traffic conditions along the Garden Corner Curves Corridor were evaluated for the four concept options. The evaluation assumed both existing and future (thirty year) analyses for the morning and afternoon peak traffic, based on Highway Capacity Manual (HCM) methodology.

Based on this evaluation, there appears to be no significant change in traffic conditions between existing and any of the four design options.

**Cultural Resources**

There may be cultural resources present within the corridor. As mentioned in Chapter 2, it is possible that the existing culvert on Hedges Creek at SW 105th Avenue and SW Blake Street has historical components. All four design options would require replacement of this culvert. As such, the presence of cultural resources should be verified during design.
CHAPTER 4: EVALUATION OF DESIGN OPTIONS

Introduction
Four concept options were developed to address the perceived concerns within the Garden Corner Curves Corridor. This chapter discusses the impacts each option may have on existing constraints within the corridor. Anticipated impacts and the estimated cost of each option will be two of the decision criteria for selecting a preferred alternative.

Safety Evaluation
Safety is a subjective exercise. In other words, it is difficult to evaluate and compare safety – particularly for improvements which are not yet built.

In developing these design options, it is important to note that the design team focused on meeting three important safety considerations, including safety design standards, comfort level for all users, and minimizing potential conflict points. These are discussed briefly in the following paragraphs.

Safety Design Standards
Design development considered safety requirements according to accepted roadway design standards. These standards include roadway geometry, sight distance requirements, signage, and striping.

Where minimum accredited standards have not achievable without significantly adverse impacts to private property and environmentally-sensitive areas, mitigation methods to improve safety were evaluated to mitigate these deficiencies.

Comfort level for all users
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**Estimated Costs**

Cost estimates were prepared for each design option, evaluating costs associated with design, permitting, and construction. **Table 4.2** below lists the estimated costs for each option. All costs assume work completed in 2017.

<table>
<thead>
<tr>
<th>Option</th>
<th>Estimated Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>$3,112,102</td>
</tr>
<tr>
<td>Option 2</td>
<td>$3,420,564</td>
</tr>
<tr>
<td>Option 3</td>
<td>$3,090,352</td>
</tr>
<tr>
<td>Option 4</td>
<td>$3,633,875</td>
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</tbody>
</table>

The total estimated costs include costs for design, permitting, ROW acquisition, construction, and construction management (engineering and inspection).

Estimates were prepared at a planning level, which is to say a conservative estimate of costs based on the relatively low level of detail available at this stage in the project. Specifically, each estimate was an AACE Class 4 estimate, for a project at an estimated 1 to 15% level of completion.

Note that these estimates assumed some level of federal funding. Federal funding is both a good potential source of funding for projects of this nature, and also a somewhat significant source of cost increases to a project – due to additional permitting and regulatory requirements.

Following public outreach a preferred option was selected. The estimated total cost of the preferred option was $3,132,112. See Appendix H for a detailed estimate.
CHAPTER 5: IMPLEMENTATION

Introduction
This chapter will discuss implementation of the proposed concept design for the Garden Corner Curves Corridor. In this context, implementation means the final design, permitting, and construction of this project.

The process of moving from concept to reality is a long one, and will require the continued commitment of the public and the City to making these improvements to the corridor. This concept plan has resulted in a preferred design alternative which addresses public, stakeholder, and City concerns. Before this project can move forward from this phase, funding will need to be obtained. Engineering design of improvements will take the project from the concept phase to final design and contract documents (construction plans). This process will also include going through the permitting process to allow adverse impacts to environmentally-sensitive areas, and to mitigate for those impacts. Finally, the project will be constructed.

Phasing Opportunities
Phasing improvements is a method by which a large project can be broken out into more manageable portions, often for constructability or financial reasons. Funding to complete design and construction of the preferred design alternative may not be available for some years to come; in this case, phasing may be warranted.

The corridor improvements discussed in this document address two basic problems: access and safety. One phasing approach would divide the solutions according to the problems. In other words, construct improvements in two phases: one addressing safety, the other addressing access.

Improving access for bicyclists and pedestrians is a problem with solutions that cannot be easily phased. For example, if the problem is no facilities for pedestrians, the solution is a continuous facility for pedestrians – adding sidewalk one phase at a time through the corridor leaves pedestrians stranded.

Improving safety however, can be phased into two general solutions: improving safety and reducing speeds for vehicles, and improving safety for all users.

Suggested phases for implementing corridor improvements are discussed in the following paragraphs.

Phase I: Short-term Safety Improvements
This phase of work would construct safety and speed reduction improvements through the corridor. It is important to note that these improvements would not provide safe continuous access through the corridor for bicyclists and pedestrians. However, simply by reducing speeds and improving safety, this phase of work would allow safer access for non-vehicular users than currently exists.

Here are some short-term speed reduction and safety strategies for the corridor:

- Pavement markings at corners – an effective speed reduction strategy at corners that provides visual delineation

Typical Speed Feedback Sign
Tualatin Garden Curves Concept Study
Chapter 5: Implementation
August 2018
Page 5-1
• Sight placement improvements – the relocation and replacement of existing signs for optimal visibility could improve safety
• Speed feedback display sign – an effective speed reduction strategy which could be implemented prior to the corners of SW 105th Ave and SW Blake St or SW 108th Ave and SW Blake St. The sign could also be relocated and reused when the preferred design alternative is constructed.
• Chevron signs at curves – the addition of chevron signs at the corners within the corridor could improve safety with a more striking visual delineation of the roadway
• Slope benching for visibility – cutting a bench in the embankment at SW 105th Ave and SW Blake St could improve visibility and safety at this curve
• Anti-speeding public awareness campaign – a long-term speed reduction strategy that is proven to work best in neighborhoods with strong sense of public involvement and community

Other improvements could be made in the short-term which would require additional engineering design, and might also benefit from more public involvement. For instance, the corridor travel lanes could receive shared lane markings – sharrows – which would provide specific direction and guidance to both bicyclists and vehicles to share the road.

Still other interim improvements could be made to the corridor that are more controversial, or may not be as applicable. For instance, speed humps were a source of strong public opinion – receiving strong love and hate – in the most recent public survey for the project.

Phase II: Access and Safety Improvements
This phase of work would construct the improvements described in the preferred alternative. This would include improving access for pedestrians and bicyclists, as well as making larger safety improvements for all users.

Potential Funding Sources
Completing this project will likely require funding from multiple sources, given the City's limited available funds for transportation improvement projects and the scope of the proposed improvements. Potential funding sources for this project will likely be a combination of local, regional, state, and federal funds. A brief summary of these funding sources is described in the following paragraphs.

Local Funding Sources
Local funding sources for this project are limited, but could include bonding and a Local Improvement District.

Bonding is a method of financing construction projects by borrowing money and paying the borrowed sum with interest back over time. Funds could be obtained by general obligation bonds approved by voters, revenue bonds, or other debt financing. This method requires smaller regular payments than the full cost of the project, but increases the total cost of the project due to interest.

Local Improvement Districts (LIDs) are special assessment districts in which property owners benefitting from a transportation improvement pay for that improvement through property tax. An LID is often politically-difficult to implement because it requires property owners to commit to paying
more in taxes. An LID might be possible for this particular project given the level of support from the community and adjacent neighborhoods for improving the corridor. However, the level of support must be significant.

In the past, the City has used Tax Increment Financing (TIF) for infrastructure improvements intended to spur economic development and redevelopment. Given the nature of this project, TIF is not likely to be a useable source of funding.

City Revenue Sources for Project Funding
A local gas tax can be a source of funding for street improvement projects. This would add a tax to fuel sold within Tualatin. There must be solid public support for a gas tax because they are instituted by vote.

The City receives funding for capital and maintenance projects from the Oregon Highway Trust Fund. This state-administered funding is collected from vehicle registration fees and state gas taxes. Funding is flexible, but is used throughout the City for a wide variety of transportation projects and maintenance needs. Approximately one (1.0) percent of this fund must be reserved for maintenance and construction of bicycle facilities.

Special Assessments
Special assessments allow local jurisdictions, with the agreement of property owners, to put into place additional property taxes to pay for specific capital projects or ongoing costs. A variety of special assessments are available in Oregon to fund a range of improvements, including sidewalks, curbs, gutters, street lighting, parking structures, and downtown or commercial zone transportation improvements. These assessments are commonly counted as revenue towards the limitations established by Measure 50.

State and Federal Funding Sources
Funding from grants at the state and federal levels could help to pay for this project. It should be noted that state and federal funds typically require a match from local funds. State funding sources are extremely limited, and often require City and regional consensus that improvements are more important than transportation needs elsewhere in the region and the state.

Washington County has a Major Streets Transportation Improvement Program (MSTIP) which funds countywide transportation system improvements. The most recent MSTIP has allocated funds to more than one project within Tualatin’s city limits, and may be a source of funding for this project. It should be noted that funding is distributed equally through the area, and that the City would have to specifically propose this project for funding. Qualifying projects must improve safety, improve traffic flow or reduce congestion, be on a major road used by many residents, and address transportation user demands. This project would address most of these criteria.

The Metropolitan Transportation Improvement Program (MTIP) is completed by Metro, who identifies how federal funds are distributed throughout the region. Municipalities compete for a pool of regional flexible funds. This project might qualify for some of these funds.
State Transportation Improvement Program (STIP). The STIP is the 4-year capital improvement program for the Oregon Department of Transportation. Funds available through the STIP are available for safety and transportation system improvements, but are highly competitive. This project might qualify for some of these funds.

The Oregon Transportation Infrastructure Bank Loan program is a statewide revolving loan fund designed to promote innovative transportation funding solutions. The Financial Services Branch of ODOT provides State support for the program. This project would be eligible to apply. It should be noted that funding is not guaranteed; projects are rated on established criteria. Repayment of loans must begin within 5 years of project completion and must be complete within 30 years or at the end of the useful life of the project.

The Oregon Department of Environmental Quality (DEQ) administers federal funding to address non-point pollution in the form of Section 319 Non-Point Source Implementation Grants. Transportation projects that integrate stormwater treatment in this manner may qualify for these funds, though funding is limited and very competitive.
APPENDIX A: ENVIRONMENTAL REVIEW AND PERMITTING ASSESSMENT MEMORANDUM
MEMORANDUM

Date: August 15, 2017

To: Dave Brokaw, PE (Wallis Engineering)

From: Eric Campbell (Campbell Environmental, LLC)

Subject: Environmental Review and Permitting Assessment for the Proposed Tualatin Garden Corner Curves Project

This memorandum discusses the results of the preliminary environmental review and permitting assessment conducted by Campbell Environmental, LLC for the proposed Garden Corner Curves Project in Tualatin, Oregon (see Figure 1). The proposed project will include roadway improvements along two curved sections of SW 105th Avenue, SW Blake Street, and SW 108th Avenue. These sections of roadway have been identified as having safety issues for pedestrians and bicyclists. The project concept study, conducted by Wallis Engineering, identified the following four alternatives, which provide various configurations for constructing new sidewalks and/or shared use paths along the roadway corridor:

**Alternative A: East Shared Use Path**
Construct a 12-foot wide shared use path on the east side of the corridor roadways for use by bicyclists and pedestrians.

**Alternative B: West Shared Use Path**
Construct a 12-foot wide shared use path on the west side of the corridor roadways for use by bicyclists and pedestrians.

**Alternative C: Sidewalk and Bike Lanes**
Construct a 5-foot wide sidewalk on the east side of the corridor roadways for use by pedestrians, and bike lanes on both sides of the road for bicyclists.

**Alternative D: Sidewalk and Bike Lanes – Both Sides**
Construct a 5-foot wide sidewalk on both sides of the corridor roadways for use by pedestrians, and bike lanes on both sides of the road for bicyclists.

This environmental review and assessment of the potential permitting requirements will assist the project team in evaluating the feasibility of the proposed project alternatives. The information presented in this memorandum is based on the results of discussions with Dave Brokaw (Project Manager at Wallis Engineering) and agency personnel, a preliminary site visit, and a review of existing baseline information, including aerial imagery and online databases.
Figure 1: Project Location Map
Garden Corner Curves Concept Study
(GoogleEarth 2017)
ENVIRONMENTAL REVIEW

Wetlands and Waters

Based on the results of the preliminary wetland/waters determination conducted by Campbell Environmental on June 22, one waterbody (Hedges Creek) and one wetland (Wetland A) were identified within the project study area (see Figure 2). Wetland A is located along the east side of SW 105th, and is associated with a roadside stormwater ditch that drains south from Paulina Road directly into Hedges Creek. The wetland determination was conducted based on the presence/absence of wetland hydrology, hydric soils, and hydrophytic vegetation, in accordance with the “Routine On-site” Determination, as described in the U.S. Army Corps of Engineers Wetland Delineation Manual, Wetlands Research Program Technical Report Y-87-1 (“The 1987 Manual”) and the Regional Supplement to the U.S. Army Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region.

Impacts to Hedges Creek and jurisdictional wetlands potentially resulting from proposed culvert replacement and road widening will be regulated by the U.S. Army Corps of Engineers (Corps) and the Oregon Department of State Lands (DSL). These resources are also considered “Water Quality Sensitive Areas” by Clean Water Service (CWS). Associated CWS development protection for water quality sensitive areas includes maintenance or restoration of “vegetated corridor” buffers around the sensitive areas. A preliminary assessment of the vegetated corridor was conducted during the wetland determination fieldwork. The location of the vegetation sampling plots are provided in Figure 2, the results of the sampling are provided as an attachment to this memorandum.

CWS vegetated corridors for streams and wetlands vary depending upon several factors including their size, seasonality (intermittent vs. perennial streams), and adjacent slope. Since Wetland A is less than 0.5 acre in size and hydrologically connected to Hedges Creek, it requires a vegetated corridor buffer of 50 feet. However, since the wetland is less than 50 feet from SW 105th Avenue, the entire area between the road and wetland are within the vegetated corridor. Hedges Creek is a perennial stream that requires a vegetated corridor buffer of 50 to 200 feet from the ordinary high water mark depending on the adjacent slope. Since Hedges Creek essentially parallels SW 105th Avenue 50-60 feet away from the road prism, all areas between the stream and the road prism are within the vegetated corridor buffer. Road, pedestrian, or bike path crossings are allowed within vegetated corridors provided the applicant can demonstrate it has minimized impacts to the extent practicable and provides adequate mitigation.

ESA-Listed Species

The lower portion of Hedges Creek (i.e., mouth to creek mile 1.7), located approximately 1.8 miles downstream of the project study area, is known to support Endangered Species Act (ESA)-listed steelhead (Oncorhynchus mykiss) under the jurisdiction of the National Marine Fisheries Service (NMFS) (StreamNet database, 2017). Lower Hedges Creek also constitutes Essential Fish Habitat as defined by the Magnuson-Stevens Act (MSA) and Essential Salmonid Habitat (ESH) as defined by the DSL.
Figure 2: Wetland Determination Map

Garden Corner Curves Concept Study

(City of Tualatin LWI overlay; provided by Wallis Engineering 2016)
The need to obtain a Section 404 Permit from the Corps to authorize project related fill within Hedges Creek and/or adjacent wetlands provides a federal nexus requiring the project to comply with Section 7 of the ESA. As such, it is anticipated that potential downstream impacts to Hedges Creek associated with proposed culvert replacement activities and post-project stormwater runoff from increased impervious surface, may require Section 7 consultation with NMFS through compliance with the terms and conditions of the 2014 programmatic opinion for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Stormwater, Transportation or Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES V for Stormwater, Transportation or Utilities).

If it is determined that the project will utilize Federal Highway Administration (FHWA) funds, administered through the Oregon Department of Transportation (ODOT), then the project will likely have to demonstrate compliance with the Federal-Aid Highway Program (FAHP) Programmatic for ESA-listed species. In addition, ODOT will likely require a No Effect Memorandum for ESA-listed terrestrial species, as well as a Botanical Clearance and Noxious Weed Management Report. Furthermore, a NEPA Categorical Exclusion document may also be required.

**Fish Passage**

Within the project study area, SW 105th Avenue crosses the headwaters of Hedges Creek via an existing 42-inch diameter CMP culvert. All four proposed project alternatives call for replacing the existing culvert with a larger (15-foot wide by 9-foot high), precast, reinforced concrete box (RCB) culvert to improve the existing hydraulic conditions at the crossing. The Oregon Department of Fish and Wildlife (ODFW) requires that any proposed replacement of an existing culvert in waters (i.e., Hedges Creek) where native migratory fish are currently or were historically present must meet state fish passage requirements.

Based on personal communication with regional ODFW biologist Tom Murtagh on December 20, 2016, it was determined that “ODFW recommends that you consider removing the entire culvert and replacing it with a culvert that meets the hydraulic capacity of the system, to protect the road from failure and getting overwhelmed should it plug during a high water event. From a fish passage perspective, native migratory fish no longer can reach this area of the basin, and therefore would not receive a net benefit in habitat access should the culvert be replaced with a fish passable structure. However, because the reach was historically used by native migratory fish, fish passage will need to be addressed. By policy, under these circumstances, you have three options; 1) Exemption from fish passage, 2) Waiver and mitigation, albeit open to discussion, and 3) meet fish passage by removing the existing culvert and replacing it with a culvert or bridge that meets State Fish Passage Criteria (which will also meet your hydraulic needs to convey the creek appropriately).”
ENVIROMENTAL PERMITTING

Given the presence of jurisdictional waters and wetlands, downstream presence of federally-listed salmonids and their habitat, and historical use of Hedges Creek by native migratory fish, the following environmental permits and approvals will likely be required for all four of the proposed project alternatives (Table 1). In addition, a formal wetland/waters delineation and concurrence will be required to identify the jurisdictional wetland boundaries and OHW of Hedges Creek within the project action area.

Table 1: Environmental Permits and Approvals

<table>
<thead>
<tr>
<th>Permit/Approval</th>
<th>Reason for Permit</th>
<th>Agency Review Timeline*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. Army Corp of Engineers Section 404 Compliance</strong></td>
<td>Fill within jurisdictional waters (Hedges Creek) and wetlands resulting from culvert replacement and road widening activities.</td>
<td>Typically 120 days after submittal of the JPA, this includes 30 days for completeness review.</td>
</tr>
<tr>
<td><strong>Department of State Lands Removal/Fill Permit</strong></td>
<td>Removal and/or fill within jurisdictional waters (Hedges Creek) or wetlands resulting from culvert replacement and road widening activities.</td>
<td>Typically 60 days after submittal of the JPA and concurrence with the Wetland Delineation Report (up to 120 days).</td>
</tr>
<tr>
<td><strong>Oregon Department of Environmental Quality Section 401 Certification</strong></td>
<td>Potential discharges to Hedges Creek associated with construction activities and stormwater runoff.</td>
<td>Typically reviewed during the 120 day timeline associated with the JPA.</td>
</tr>
<tr>
<td><strong>SLOPES V Programmatic Approval</strong></td>
<td>Potential downstream impacts to ESA-listed salmonid species resulting from construction activities and/or post-project stormwater runoff.</td>
<td>Reviewed during the 120 day timeline associated with the JPA.</td>
</tr>
<tr>
<td><strong>Oregon Department of Fish and Wildlife Fish Passage Approval</strong></td>
<td>Replacement of existing culvert crossing at Hedges Creek, and current or historic presence of native migratory fish.</td>
<td>Typically 30 to 60 days after submittal of the Fish Passage application.</td>
</tr>
</tbody>
</table>
In addition to the environmental permits and approvals listed above, the proposed project may also require a Section 106 cultural resources review, a National Pollutant Discharge Elimination System (NPDES) permit, and a local land use approval for construction.

The Oregon Department of Fish and Wildlife (ODFW)-preferred in-water work window (IWWW) for Hedges Creek is July 15 – September 30. Project design will need to be carried out in a manner that allows for construction to be completed below the OHW of Hedges Creek during the ODFW-preferred, or other agency approved, IWWW.

POTENTIAL MITIGATION REQUIREMENTS

The four proposed project alternatives will likely each result in permanent impacts to Hedges Creek, adjacent wetlands, and associated vegetated corridor buffers. As such, compensatory mitigation will be required. It is possible that impacts to Hedges Creek may be offset by associated improvements to the existing culvert crossing, and hence the overall hydraulic conditions of the stream. However, additional mitigation (i.e., creek bank restoration or payment-in-lieu) may be required for any net fill within the stream channel. Mitigation for wetland impacts, if applicable, could be accomplished through onsite mitigation or by purchasing mitigation credits from a local mitigation bank (i.e., Tualatin Valley, Half Mile Lane ILF, or Butler). Wetland and waters mitigation planning would require coordination with the Corps and DSL.

Mitigation for impacts to CWS vegetated corridors can include the expansion of onsite corridors, the planting of offsite resources, or utilization of CWS’ Vegetated Corridor Payment to Provide (PTP) fee structure. In addition to mitigation measures for impacts to vegetated corridors, CWS also requires “enhancement” of any unimpacted area of vegetated corridor remaining within the site boundary. Enhancement is required for any proposed development within the site boundary (even if direct impacts are avoided), and generally includes a combination of removal of non-native invasive species and native plant re-vegetation. Specific mitigation requirements will vary depending upon the type of resource impacted (e.g., wetland or stream vs. vegetated corridor) and size of the impact. In addition, CWS has some discretion to modify mitigation requirements for impact scenarios that do not fall within those specifically described in its code. Therefore, this initial determination on mitigation requirements cannot be confirmed until the City of Tualatin consults with CWS on its preferred design alternative and associated resource impacts.
SUMMARY

Given the exiting baseline conditions and presence of jurisdictional resources within the project study area, and based on the proposed design alternatives, it appears that the environmental permitting requirements for all four project alternatives will be equivalent. However, given that the proposed roadway/pathway design width associated with Alternative 4 is approximately 7 to 10 feet wider than the other three proposed alternatives, it is likely that Alternative 4 will result in more impact to Hedges Creek, adjacent wetlands, and associated vegetated corridors. As such, although a viable alternative, Alternative 4 will likely result in slightly higher mitigation costs.

If you have any additional questions or information needs please feel free to contact me directly.

Sincerely,

Eric Campbell, Principal
Campbell Environmental, LLC
503-680-8390
eric@campbellenviro.com

Attachments
<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Stratum</th>
<th>% Cover</th>
<th>Native, Non-native, Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigleaf maple</td>
<td>Acer macrophyllum</td>
<td>T</td>
<td>75</td>
<td>Native</td>
</tr>
<tr>
<td>Indian plum</td>
<td>Oemleria cerasiformis</td>
<td>S</td>
<td>30</td>
<td>Native</td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>Rubus armeniacus</td>
<td>S</td>
<td>5</td>
<td>Invasive</td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Corylus cornuta</td>
<td>S</td>
<td>20</td>
<td>Native</td>
</tr>
<tr>
<td>Lady fern</td>
<td>Athyrium filix-femina</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Pacific waterleaf</td>
<td>Hydrophyllum tenuipes</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Field horsetail</td>
<td>Equisetum arvense</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Fowl managrass</td>
<td>Glyceria striata</td>
<td>H</td>
<td>&lt;5</td>
<td>Native</td>
</tr>
<tr>
<td>English ivy</td>
<td>Hedera helix</td>
<td>V</td>
<td>&lt;5</td>
<td>Invasive</td>
</tr>
</tbody>
</table>

**Veg Plot 2- Poor**

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Stratum</th>
<th>% Cover</th>
<th>Native, Non-native, Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Himalayan blackberry</td>
<td>Rubus armeniacus</td>
<td>S</td>
<td>40</td>
<td>Invasive</td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Corylus cornuta</td>
<td>S</td>
<td>15</td>
<td>Native</td>
</tr>
<tr>
<td>Field horsetail</td>
<td>Equisetum arvense</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Lady fern</td>
<td>Athyrium filix-femina</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>English ivy</td>
<td>Hedera helix</td>
<td>V</td>
<td>25</td>
<td>Invasive</td>
</tr>
</tbody>
</table>

**Veg Plot 3- Good**

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Stratum</th>
<th>% Cover</th>
<th>Native, Non-native, Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red alder</td>
<td>Alnus rubra</td>
<td>T</td>
<td>10</td>
<td>Native</td>
</tr>
<tr>
<td>Pacific willow</td>
<td>Salix lasiandra</td>
<td>S</td>
<td>45</td>
<td>Native</td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Corylus cornuta</td>
<td>S</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>Rubus armeniacus</td>
<td>S</td>
<td>15</td>
<td>Invasive</td>
</tr>
<tr>
<td>English ivy</td>
<td>Hedera helix</td>
<td>V</td>
<td>30</td>
<td>Invasive</td>
</tr>
<tr>
<td>Stickywilly</td>
<td>Galium aparine</td>
<td>H</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Cranesbill</td>
<td>Geranium sp.</td>
<td>H</td>
<td>15</td>
<td>Introduced?</td>
</tr>
</tbody>
</table>

**Veg Plot 4- Good**

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Stratum</th>
<th>% Cover</th>
<th>Native, Non-native, Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigleaf maple</td>
<td>Acer macrophyllum</td>
<td>T</td>
<td>50</td>
<td>Native</td>
</tr>
<tr>
<td>Vine maple</td>
<td>Acer ciracinatum</td>
<td>S</td>
<td>20</td>
<td>Native</td>
</tr>
<tr>
<td>Indian plum</td>
<td>Oemleria cerasiformis</td>
<td>S</td>
<td>30</td>
<td>Native</td>
</tr>
<tr>
<td>Oregon ash</td>
<td>Fraxinus latifolia</td>
<td>H (seedling)</td>
<td>5</td>
<td>Native</td>
</tr>
<tr>
<td>Field horsetail</td>
<td>Equisetum arvense</td>
<td>H</td>
<td>&lt;5</td>
<td>Native</td>
</tr>
<tr>
<td>California blackberry</td>
<td>Rubus ursinus</td>
<td>V</td>
<td>&lt;5</td>
<td>Native</td>
</tr>
</tbody>
</table>
### Wetland A (included for general description, not relevant to corridor condition)

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skunk cabbage</td>
<td><em>Lysichiton americanus</em></td>
</tr>
<tr>
<td>Speedwell</td>
<td><em>Veronica sp.</em></td>
</tr>
<tr>
<td>Oregon ash</td>
<td><em>Fraxinus latifolia</em></td>
</tr>
<tr>
<td>Nightshade</td>
<td><em>Solanum dulcamara</em></td>
</tr>
<tr>
<td>Fowl mannagrass</td>
<td><em>Glyceria striata</em></td>
</tr>
<tr>
<td>Annual bluegrass</td>
<td><em>Poa annua</em></td>
</tr>
<tr>
<td>Small fruited bulrush</td>
<td><em>Scirpus microcarpus</em></td>
</tr>
</tbody>
</table>

### On-site Sensitive Area

<table>
<thead>
<tr>
<th>On-site Sensitive Area</th>
<th>Watershed size (acres)</th>
<th>Adjacent slope %</th>
<th>Width of Vegetated Corridor (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;10</td>
<td>≥10–&lt;50</td>
<td>≥50–&lt;100</td>
</tr>
<tr>
<td>Hedges Creek-West of SW 105&lt;sup&gt;th&lt;/sup&gt; Ave</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hedges Creek-East of SW 105&lt;sup&gt;th&lt;/sup&gt; Ave</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<sup>1</sup> Width of vegetated corridor is limited to distance between edge of the stream channel and the toe of the road prism and only includes areas within the SW 105<sup>th</sup> Avenue right-of-way. Actual corridor width estimated to range from 15 feet west of SW 105<sup>th</sup> Avenue to 30 feet east of SW 105<sup>th</sup> Avenue.

### Wetland A

<table>
<thead>
<tr>
<th>On-site Sensitive Area</th>
<th>Wetland size (acres)</th>
<th>Adjacent slope %</th>
<th>Isolated</th>
<th>Width of Vegetated Corridor (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;0.5</td>
<td>&gt;0.5</td>
<td>&lt;25</td>
<td>&gt;25</td>
</tr>
<tr>
<td>Wetland A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Width of vegetated corridor is limited to distance between edge of wetland and the toe of the road prism and only includes areas within the SW 105<sup>th</sup> Avenue right-of-way. Actual corridor width estimated to be <15 feet east of SW 105<sup>th</sup> Avenue. The vegetated corridor between the wetland and SW 105<sup>th</sup> Avenue is mostly unvegetated and would be considered degraded.
To: David Brokaw PE, Project Manager  
Wallis Engineering  

From: Samuel E Giese PE, Columbia Pacific Engineering LLC  

Date: August 1, 2017  

RE: Garden Corner Curves  
Conceptual Culvert Design for Hedges Creek at SW 105th Rd  

Background  

A segment of roadway consisting of portions of SW 105th Ave., SW Blake St and SW 108th Ave. in Tualatin, Oregon has been identified as having safety issues for pedestrians and bicyclists. A feasibility study by Wallis Engineering is currently underway to look at possible alternatives for improving safety on this stretch known as the Garden Corner Curves. As part of this study, Columbia Pacific Engineering LLC (CPE) has been asked to prepare a conceptual design for improving the crossing of SW 105th Ave. over Hedges Creek, a tributary to the Tualatin River. The existing crossing is undersized and is subject to overtopping for flows from a 2 year recurrence interval runoff event.  

Existing Data  

CH2MILL prepared a technical memo (2012) regarding Constraints and Opportunities for the site. This included a brief discussion of the hydraulics at this location. This was used as the starting point for the conceptual design. Clean Water Services (CWS) performed hydraulic and hydrological modeling for this reach of Hedges Creek as part of the Watershed 2000 project. The HEC-RAS model (dated 3/6/2006) was obtained from the CWS website. The Flood Insurance Study (FIS) for Washington County, Oregon and Incorporated Areas (Effective 11/4/2016) was also reviewed. The exhibits prepared by Wallis Engineering for public outreach  

At this stage of the project, no topographic survey has been performed. LiDAR mapping by Oregon DOGAMI (2007) in the form of ASCII mass points (NAVD88) was downloaded and a surface model developed using Carlson Civil software. A 1 foot contour map was created (Attachment A). The HEC-RAS model contains two surveyed sections and the existing culvert data. These are the only sources of topographic data for this report and the conceptual design should be considered accordingly. The
greatest uncertainty will be seen in the excavation volumes based on LiDAR and the details for the downstream channel connection.

Site Observations

The site was visited on June 21 2017. Conditions were very brushy and the downstream stream was not accessible. Approximately 250 feet of the upstream channel was walked and bankfull measurements were made. Several things were quite evident.

- The existing pipe is 42 inches in diameter rather than the 36 inches previously identified and modeled. The inlet, while in a rockery headwall, is slightly damaged and bent out of shape.
- The riparian vegetation was dominated by invasive species such as evergreen blackberries, English ivy and some reed canary grass.
- There is silt and sandy sediment built up at the culvert inlet. The stream has cut down into this material and has a steep slope (roughly 8 % for the first 30 feet) into the culvert.
- The channel is largely silt bottom with some highly embedded gravel/cobble. This is sub angular basalt and may be from bank armoring upstream.
- The channel form is roughly trapezoidal and incised 2-3 feet. The average upstream bankfull width over the 250 feet is 9-10 feet.

Design approach

The existing model was reviewed. As indicated in the CH2MILL work, SW 105th Ave. is inundated by backwatering from the downstream crossing at SW 108th Ave. For the purposes of this conceptual design, revising the existing HEC-RAS model is outside the scope of this report. The FHWA culvert analysis software HY-8 was used. The downstream crossing was not included in order to look at open channel conditions at this crossing. Comparison of top of roadway elevations from the model and the contour data showed a difference of + 4.4 feet of elevation. The FIS shows a conversion from NGVD 29 (often used previously in FIS work) to NAVD88 of +3.52. There is evidently an additional datum issue. The NAVD88 was chosen for this design, since the future survey will likely use this datum. The elevations from the model for the culvert and channel were adjusted to the NAVD88.

Profiles were cut from the LiDAR data for the road centerline, the stream channel and a downstream cross section. The flows from the model, based future land use in the basin were used for the HY-8 input data.
The existing culvert geometry and downstream section were added and the crossing was analyzed. With the increased diameter (from 36 to 42 inches) the results were similar to those from CH2MILL, with the roadway overtopping at the 2 year flow.

Based on the bankfull measurements a design span of 15 feet was chosen (Attachment B). This is based on bankfull width x 1.5 per current fish passage standards (SLOPES IV). Available steel culvert shapes were reviewed and again per the CH2MILL work, there is not sufficient pipe cover. A reinforced concrete box (RCB) (four sided) was chosen. Indications are that subgrade conditions may be soft. The four sided box will require less foundation work since it will act as a slab foundation. It will also provide additional protection from scour. The box will be countersunk 3 feet and filled with stream gravel. This results in a 9 foot rise. The box invert will be at 190.0 with a channel elevation of 193.0. The existing culvert skew was held. Assuming the skew, a roadway section of 41 feet (Option C) and allowing an additional 4 feet each side for wall and or guardrail the culvert length will be 55 feet at zero grade.

This design was analyzed and the results shown in the table attached (Attachment C). Maximum velocity for the 2 and 100 year flows are 2.9 and 5.1 fps. The freeboard inside the box is 1.5 feet for the 100 year event.

Due to the current location of the channel either close to or within the new roadway prism, it is recommended that the stream be realigned up and downstream until out of the fill area. This will require approximately 320 feet of new channel.

Based on the observed poor habitat conditions (silty substrate, signs of channel modification from “peaky” urban flows), it may be worthwhile to make the case to the USACE that fish use will be minimal if fish access is made available. It is not certain that if habitat restoration is implemented, that it will be sustainable due to the urbanized watershed condition and resulting hydrology. Based on that possibility, I ran a second scenario based on strictly hydraulic considerations. This is identical to the first with a 10 foot span.
This resulted in higher velocities. Maximum velocity for the 2 and 100 year flows are 4.6 and 7.6 fps. The freeboard inside the box is 1.0 feet for the 100 year event. If fish passage is not an issue, this design is workable.

Conceptual estimates were prepared for both the 10 foot (§318k) and 15 foot (§382k) spans. These are attached (Attachment D). Without survey data and recent metro area bid tabs for these types of boxes, there is a fair degree of uncertainty involved. A 30% contingency was used. Costs may be reduced by using one of the alternatives with a narrower roadway section. Careful planning of bidding such as a winter advertisement with greater competition could also help. A sketch of the culvert section and profile (15 foot option) is attached.

**Conclusions**

Based on partial bankfull measurements, a 15 foot span x 9 foot rise RCB should meet both hydraulic and fish passage goals. The projected costs are based on a worst case of a 50 foot road/pathway width. The choice of a road/pathway improvement option with a smaller footprint will reduce the costs of the culvert upgrade. Channel realignment will be required due to the proximity of the stream parallel to the existing roadway prism. The possibility of not providing fish passage due to degraded habitat conditions should be explored with the regulators.

Data needed for a final design includes:

- Topographic survey data including a stream profile for 250 feet up and downstream, bankfull measurements and cross sections.
- Geotechnical investigation.
- A stream habitat assessment may be useful if there appears to be flexibility on the part of permitting agencies regarding fish passage. This would help the argument that the habitat upstream is not good enough to warrant the additional cost of a wider box.
Install Precast Concrete 4 Slab Box Culvert 15 foot Span x 9 foot Rise with 10 foot Wing Walls @45 degrees L = 55 feet Skew = 20 degrees

Contours from DOGAM LiDAR 2007

SW 105th Ave

Garden Corner
Curves
Feasibility Study
Garden Corner Curves Culvert

Profile

5+20

Crown elevation = 199.18
Existing Grade SW 105th Ave

Hedges Creek

200

Channel elevation = 193.0
Box invert elevation = 190.0
Slope = 0.0 ft/ft

Stream Gravel (3 ft deep)

190

Install Precast Concrete 4 Sided
Box Culvert 15 foot Span x 9 foot Rise
with 10 foot Wing Wells @45 degree
L = 55 feet Skew = 20 degrees

6+00

Section

1+80

Existing Grade SW 105th Ave

Crown elevation = 199.18

Stream Gravel (3 ft deep)

190

Channel elevation = 193.0
Box invert elevation = 190.0
Slope = 0.0 ft/ft

180

SEG/ 7-31-2017
HY-8 Analysis Results

Culvert Summary Table - 42 inch CMP

Culvert Crossing: Hedges Creek

<table>
<thead>
<tr>
<th>Discharge Names</th>
<th>Total Discharge (cfs)</th>
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<th>Headwater Elevation (ft)</th>
<th>Inlet Control Depth(ft)</th>
<th>Outlet Control Depth(ft)</th>
<th>Flow Type</th>
<th>Normal Depth (ft)</th>
<th>Critical Depth (ft)</th>
<th>Outlet Depth (ft)</th>
<th>Tailwater Depth (ft)</th>
<th>Outlet Velocity (ft/s)</th>
<th>Tailwater Velocity (ft/s)</th>
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<td>150.00</td>
<td>97.06</td>
<td>200.86</td>
<td>7.60</td>
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## HY-8 Analysis Results

### Culvert Summary Table - 15 ft span

Culvert Crossing: Hedges Creek

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<th>Inlet Control Depth(ft)</th>
<th>Outlet Control Depth(ft)</th>
<th>Flow Type</th>
<th>Normal Depth (ft)</th>
<th>Critical Depth (ft)</th>
<th>Outlet Depth (ft)</th>
<th>Tailwater Depth (ft)</th>
<th>Outlet Velocity (ft/s)</th>
<th>Tailwater Velocity (ft/s)</th>
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<td>231.00</td>
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## HY-8 Analysis Results

### Culvert Summary Table - 10 ft span

**Culvert Crossing: Hedges Creek**

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<th>Inlet Control Depth(ft)</th>
<th>Outlet Control Depth(ft)</th>
<th>Flow Type</th>
<th>Normal Depth (ft)</th>
<th>Critical Depth (ft)</th>
<th>Outlet Depth (ft)</th>
<th>Tailwater Depth (ft)</th>
<th>Outlet Velocity (ft/s)</th>
<th>Tailwater Velocity (ft/s)</th>
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</thead>
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<td>150.00</td>
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<td>2.48</td>
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<td>4.41</td>
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**Culvert Construction (15 ft Span Box)**

Garden Corner Curves  
Hedges Creek at SW 105th Ave.  
6/28/2017  rev 7/28/2017

<table>
<thead>
<tr>
<th>Item #</th>
<th>Quantity</th>
<th>Description</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>MOBILIZATION AND BONDING(8%)</td>
<td>L.S.</td>
<td>$30,000.00</td>
<td>$30,000.00</td>
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<td>$5,000.00</td>
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<td>$1,000.00</td>
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<tr>
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<td>$176.00</td>
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<td>$3,000.00</td>
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<td>$6,650.00</td>
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**Subtotal** $293,396.00  
**Contingency at 30%** $88,018.80  
**CONSTRUCTION TOTAL** $381,414.80

**Assumptions:**  
15 foot span x 9 foot rise reinforced concrete box in place  
10 foot bankful width  
3 foot box embedment  
Includes only work below road subgrade NIC walls  
Holds existing culvert skew and grade  
Volumes based on LiDAR  
175 LF downstream, 145 LF of upstream channel realignment
<table>
<thead>
<tr>
<th>Item #</th>
<th>Quantity</th>
<th>Description</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
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<td>$9,000.00</td>
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<td>$1,200.00</td>
</tr>
<tr>
<td>18</td>
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Subtotal $244,788.00

Contingency at 30% $73,436.40

CONSTRUCTION TOTAL $318,224.40

Assumptions:
- 10 foot span x 9 foot rise reinforced concrete box in place
- 10 foot bankful width
- 3 foot box embedment
- Includes only work below road subgrade NIC walls
- Holds existing culvert skew and grade
- Volumes based on LiDAR
- 175 LF downstream, 145 LF of upstream channel realignment
APPENDIX C: WARNING SIGNAL MODIFICATION
ALTERNATIVES MEMORANDUM
The Garden Curves corridor consists of three narrow roadways within the City of Tualatin – SW 108th Avenue, SW Blake Street, and SW 105th Avenue. The corridor does not currently meet the City’s street design standards, and presents numerous safety and access concerns for vehicles, pedestrians, and bicyclists. In order to address these concerns, the City is completing a concept study for the corridor with Wallis Engineering and Alta Planning + Design. Separate from this corridor study, but related, the City directed Wallis Engineering to complete a memorandum regarding an existing warning signal system recently installed within the corridor.

The purpose of this memorandum is to describe the existing warning signal system within the Garden Curves corridor, discuss deficiencies associated with the system, and provide recommendations for modifying the signal to address these deficiencies.

**Existing Conditions**

A pedestrian warning signal system was installed in 2012 in order to address neighborhood safety concerns associated with pedestrians and bicyclists sharing the limited roadway pavement.

The signal system was designed to alert vehicles to the presence of pedestrians and bicyclists, and consists of four actuated-signal poles. A site map showing the locations of the poles is included on the next page as **Figure 1**. Photos of each pole are attached to this memo as **Exhibit A**. The pole location and components are summarized in **Table 1**.
Figure 1: Site Map
### Table 1: Existing Warning Signal System

<table>
<thead>
<tr>
<th>Pole #</th>
<th>Location</th>
<th>Sign Type / ‘Text’ / Size (in) / Facing Direction</th>
<th>Pole Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>SW 105th Ave north of Moratoc Dr on west side of roadway</strong></td>
<td>• W11-15 with integral LED flashers / Combination Bike and Ped Crossing Symbol / 48x48 / N&lt;br&gt;• W16-3P / ‘Next ½ Mile’ / 30x24 / N&lt;br&gt;• Custom / ‘PUSH HERE TO ACTIVATE SAFETY LIGHTS TO CONTINUE ON TO BLAKE STREET’ / 9x15 / W&lt;br&gt;• R10-25 / ‘push button to turn on warning lights’ / 5x8 / W</td>
<td>• Pole-mounted solar cell&lt;br&gt;• Pedestrian push button&lt;br&gt;• Wireless controller box</td>
</tr>
<tr>
<td>2</td>
<td><strong>SW 105th Ave &amp; SW Pauline Dr at end of sidewalk on east side of roadway</strong></td>
<td>• Custom / ‘PUSH HERE TO ACTIVATE SAFETY LIGHTS TO CONTINUE ON TO BLAKE STREET’ / 9x15 / E&lt;br&gt;• R10-25 / ‘PUSH BUTTON TO TURN ON WARNING LIGHTS’ / 5x8 / E</td>
<td>• Pole-mounted solar cell&lt;br&gt;• Pedestrian push button&lt;br&gt;• Wireless controller box</td>
</tr>
<tr>
<td>3</td>
<td><strong>Corner of SW 108th Ave &amp; SW Blake St on west side of roadway</strong></td>
<td>• Custom / ‘PUSH HERE TO ACTIVATE SAFETY LIGHTS TO CONTINUE ON TO BLAKE STREET’ / 9x15 / S&lt;br&gt;• R10-25 / ‘PUSH BUTTON TO TURN ON WARNING LIGHTS’ / 5x8 / S</td>
<td>• Pole-mounted solar cell&lt;br&gt;• Pedestrian push button&lt;br&gt;• Wireless controller box</td>
</tr>
<tr>
<td>4</td>
<td><strong>SW 108th Ave south of SW Blake St at end of southbound bike lane and sidewalk</strong></td>
<td>• W11-15 with integral LED flashers / Combination Bike and Ped Crossing Symbol / 48x48 / N&lt;br&gt;• W16-3P (‘NEXT ½ MILE’ / 30x24 / N&lt;br&gt;• Custom / ‘PUSH HERE TO ACTIVATE SAFETY LIGHTS TO CONTINUE ON TO BLAKE STREET’ / 9x15 / S&lt;br&gt;• R10-25 / ‘PUSH BUTTON TO TURN ON WARNING LIGHTS’ / 5X8 / S&lt;br&gt;• R10-25 / ‘PUSH BUTTON TO TURN ON WARNING LIGHTS’ / 5x8 / W</td>
<td>• Pole-mounted solar cell&lt;br&gt;• Pedestrian push button&lt;br&gt;• Wireless controller box</td>
</tr>
</tbody>
</table>

The W11-15 sign with integral LED lights flashes when the signal is activated by any of the push buttons installed throughout the corridor. These flashers remain active for approximately 10 minutes.

**Existing Deficiencies**

The current signal system has several deficiencies, which can be generally defined as unclear communication to drivers, unclear direction and communication to pedestrian and bicyclists, and lack of ADA-compliance. These deficiencies are discussed in the following paragraphs.

**Unclear Communication to Drivers**

The warning signal system does an inadequate job of communicating to drivers the presence of pedestrians and bicyclists within the roadway, and the expectations for driver behavior. Specifically, the system uses unclear signage, lacks advance warning signage, lacks reinforcement signage, has placement issues, and limited visibility.

The current sign is a warning sign, described by MUTCD as used to draw driver attention to unexpected or unusual roadway circumstances. According to the MUTCD and observed usage, the existing warning sign (W11-15) is typically used to warn drivers of a location within the roadway where pedestrians and bicyclists...
may be crossing the road. **Figure 2** to the right shows a W11-15 sign with flashers which is part of the existing signal system.

For this corridor, the intent of the sign is to warn drivers of the presence of bicyclists and pedestrians in the roadway for a certain distance during the time in which the flashing lights are on. This may be the intent, but it is not adequately communicated by use of a W11-15 sign. Not only is a roadway with shared multimodal facilities an unusual situation for drivers to encounter, the use of a typical sign for this atypical situation is potentially confusing, rather than helpful. The expectation that drivers should yield to pedestrians and bicyclists in the roadway is not stated or implied by this sign.

The warning signal system does not include any signage in advance of the signal. The existing signs are located at the terminus of the sidewalk and bike lanes – in other words, the signal is located at the very place where a driver could expect pedestrians and bicyclists to enter the roadway. This does not contradict MUTCD guidelines for this type of warning sign (W11-15). However, the typical use of this sign is for a pedestrian/bicyclist crossing location - rather than to warn drivers that other users will be sharing the road. For drivers that do not see the warning signal and associated signage, there is no reinforcement of the message that pedestrians and bicyclists may be present in the roadway.

The location of the warning signal at SW 105th Ave north of Moratoc Drive is problematic. That signal is located in advance of two intersections on SW 105th Ave. Drivers turning from SW Pauline Drive or SW Moratoc Drive onto SW 105th Avenue are not alerted by the signal.

In addition, the flashing lights on the W11-15 warning signs are visible during dark or cloudy conditions, but their visibility decreases dramatically with increasing sunlight.

**Unclear Direction to Pedestrians and Bicyclists**

The existing warning signal system does an inadequate job of directing pedestrians and bicyclists through the corridor. The purpose of the signal activation is inadequately communicated, the expected travel route is not stated on any signs, and the duration and time remaining to travel the corridor is not communicated to the user.

The fact that the sidewalk and bike lanes are ending is not indicated by signage prior to the end of these facilities. Because of the limited useable public Right-of-Way through the corridor, there is limited shoulder for pedestrians and bicyclists to travel in, and they typically travel within the paved surface. The expectation that all users will need to share a constrained roadway through the corridor is not plainly communicated. On a simpler note, the orientation of the signs on all of the poles - except Pole #4 - fail to account for all the directions from which pedestrians might approach the signal.

Once activated, the signal flashes for a duration of ten (10) minutes. While most pedestrians and bicyclists can travel the corridor in this time period, not all users are capable of doing so. In addition, users are not alerted to the fact that the signal will stop flashing after ten minutes. The closest equivalent to this type of signal would be a crosswalk signal, which communicates the amount of time remaining to travel a distance to the user, and also communicates when it is unsafe to travel. This signal communicates neither piece of information.

**Issues with ADA Compliance**

It should also be noted that there are a number of deficiencies associated with ADA compliance at the warning signal poles. These are summarized in the following table.
Table 2: Issues with ADA Compliance

<table>
<thead>
<tr>
<th>Pole #</th>
<th>Location of Pole</th>
<th>Issues with ADA Compliance</th>
</tr>
</thead>
</table>
| 1      | SW 105th Ave north of Moratoc Dr on west side of roadway | • Inadequate landing area  
• Excessive cross-slope in landing area  
• No detectable warning surface |
| 2      | SW 105th Ave & SW Pauline Dr at end of sidewalk on east side of roadway | • Excessive cross and longitudinal slopes at curb ramp  
• Inadequate landing area and location at curb ramp  
• Push button located over grass surface  
• No detectable warning surface |
| 3      | Corner of SW 108th Ave & SW Blake St on west side of roadway | • Excessive cross and longitudinal slopes at curb ramp, excessive lip  
• Inadequate landing area  
• No detectable warning surface |

Potential Interim Improvements

The warning signal system has several deficiencies, and depending on the future use of the corridor, may not be of value. However, prior to implementing the improvements dictated by the corridor study, there are a number of potential interim improvements to the warning signal system which could improve its functionality. These include the following: replacement and additional signage, ADA improvements, visibility enhancements, and signal actuation improvements.

It is important to recognize that the current system operates to warn drivers of the presence of other users in the roadway for a designated period of time. The flashing lights – the signal portion of the system - denote that period of time. There are two general options with improving the warning signal system: remove the flashing lights, or more clearly communicate the intent and duration of the flashing lights to all users.

For both options, interim improvements as described in the following paragraphs should be considered.

Replacement and Additional Signage

As discussed, the current signage for the warning signal system is deficient in communicating to all users the nature of the shared roadway and the expectations for their behavior. Given the constrained nature of the roadway, sight distance obstructions at corner and curves, and the purpose of the roadway to accommodate all users, we recommend at a minimum the installation of replacement and additional signage. This could include regulatory as well as warning signage, advance warning signage, recurrent warning signage, and clarification signage for all users.

As mentioned, the use of the W11-15 signage is atypical for the circumstance of a shared roadway for pedestrians, bicyclists, and vehicles. Though there is no current MUTCD guidance for this circumstance, there are instances of signs being used to indicate shared roadways. Figure 3 to the right is an example of an available roadway sign which directs all users to be aware and share the road with one another. This or a similar type of sign could be used to draw attention to the shared nature of the road, or to reinforce the presence of pedestrians and bicyclists within the roadway.

The MUTCD does not make specific recommendations for advance signage in this particular scenario. Generally speaking, the MUTCD advises that warning signs should be placed a minimum of 100 feet in...
advance of where the warning condition is located. However, the use of the warning signal system as a warning that pedestrians and cyclists will be using the road—not simply crossing it—is an unusual circumstance. In this instance, it is advisable to include advance signage to draw attention to the change in the roadway use.

Recurrent signage to draw driver attention to the road use may also be of value. As discussed, two streets intersect SW 105th Avenue south of the warning signal, and drivers traveling from those streets should be alerted of the change in the roadway use.

Currently, the guidance at the warning signal system is deficient. It may be of value to add clarification signage which communicates the following information to non-vehicular users:

- Sidewalk ends
- Bicycle lane ends
- Road narrows
- No protected pedestrian and bicyclist facilities
- Use caution when sharing roadway
- Bicyclists and pedestrians ‘in roadway when lights are flashing’

As discussed earlier, the intent of the signal is to communicate to drivers that while the sign flashes, a warning condition exists. However, this is intuitive rather than directly communicated. Similarly, the duration of the signal lights are not communicated to pedestrians and bicyclists. If the signal portion of the warning system is deemed to be of value, then improvements should be made to more effectively communicate the intent and nature of the system.

**ADA Improvements**

As discussed, the existing warning signal poles are not fully compliant with ADA. If the warning signal system is to remain, these deficiencies should be addressed. Specifically, landing areas which are deficient in dimensions or grades should be replaced, and detectable warning surfaces should be applied to existing curb ramps. The location of the push button at the pole on SW 105th Ave and SW Pauline Dr is deficient, and should be reoriented to a more accessible location.

**Visibility Improvements**

The existing lights on the warning signal signs are not sufficiently bright on a sunny day to be visible to drivers. If the City elects to keep the flashing lights, some improvements should be made to the visibility of these lights such that they are clear and obvious throughout all conditions.

**Signal Actuation Improvements**

If City elects to keep the signal-actuation portion of the warning signal system, they may wish to extend the duration of the flashing lights beyond 10 minutes in order to accommodate a wider range of pedestrian users. The City may also consider the addition of bicycle detection or additional bicycle oriented push buttons. Currently, only the signal on SW 108th has a bicyclist-oriented push button.
Exhibit A
Photos of Signal Actuated Poles

Pole #1 Looking Southbound on SW 105th Ave

Pole #2 Looking Southbound on SW 105th Ave at SW Paulina Dr

Pole #3 Looking Northbound on SW 108th Ave

Pole #4 Looking Northbound on SW 108th Ave
Exhibit A
Photos of Signal Actuated Poles

Pole #4 Pedestrian push button and signage

Pole #4 Bicyclist push button and signage
APPENDIX D: PUBLIC ENGAGEMENT SUMMARY
MEMORANDUM
MEMO

Tualatin Garden Corner Curves

DATE: August 28, 2017
RE: Public Engagement Summary Memo

Overview

This document summarizes the public engagement conducted to date for involving stakeholders and informing the public about the Garden Corner Curves (GCC) project. The public outreach strategy utilized many tools of engagement to reach stakeholders and the broader community, such as some online surveys, a project website, a variety of community meetings, and a closed-corridor site tour. Primary stakeholders included landowners and residents who would be directly affected by alignment choices, people who live in the general area, and stakeholders who may potentially be impacted by changes to traffic patterns.

Public Involvement Strategy Goals

As stated in the project Public Involvement Strategy, the City of Tualatin is committed to public engagement that:

- Provides early and ongoing opportunities for stakeholders to raise issues and concerns
- Facilitates equitable and constructive communication between the public and project team
- Empowers residents to become involved with the project
- Enables experiential review and participation in the design process
- Provides the public with balanced and objective information to help the public understand issues, alternatives, opportunities, solutions, and related costs
- Builds on existing communication networks and resources
- Enhances the project outcome and acceptance within the community

Listening Phase – Public Outreach Summary

Feedback was gathered before beginning any design work, during the “listening phase” of the GCC public engagement process. Some common themes emerged from community members that later helped shape the design alternatives. The following infographic describes the most common themes heard during this process:
City of Tualatin
GARDEN CORNER CURVES
Public Outreach Summary

CORRIDOR EXPERIENCE:

90% of survey respondents live immediately adjacent to the corridor or in an adjoining neighborhood

Many residents walked the corridor for the first time at the street closure event

71% of survey respondents travel on the corridor every day

SURVEY RESPONDENTS SAID:

98% do not feel safe walking on this corridor

97% do not feel safe biking here

58% said there are no safe and convenient alternate routes for walking or biking

TOP SAFETY CONCERNS:

No bike lanes

No sidewalks

Blind corners and limited visibility
Outreach to Date
As outlined in the project Public Involvement Plan, the GCC public engagement process comprised three categories of outreach. To date, the project team has accomplished the following:

- General Outreach Tools
  - Information sharing in the City of Tualatin’s newsletter
  - Two articles in the Ibach CIO newsletter
  - Information sharing by stakeholders via Next Door
  - Additional City outreach via website and social media posts
  - Project postcards mailed to all residents of the Ibach and Midwest neighborhoods
  - Multiple Facebook posts
  - Emails to the project contact list

- Targeted Stakeholder Outreach
  - Stakeholder meetings with affected property owners
  - Kitchen table meetings (small neighborhood meetings hosted by neighbors near the corridor)
  - Presentation at the Ibach Community Involvement Organization’s (CIO) meeting

- Public and Online Events
  - Corridor site tour
  - Two virtual corridor tour videos
  - Two online surveys
  - Project website and updates throughout the engagement process.
  - City Council presentation
  - Open house

<table>
<thead>
<tr>
<th>Outreach Meeting</th>
<th>Meeting Date</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Meeting</td>
<td>September 19, 2016</td>
<td>1 Property Owner</td>
</tr>
<tr>
<td>CIO Meeting - Project Update</td>
<td>October 3, 2016</td>
<td>18 Attendees</td>
</tr>
<tr>
<td>Closed Street Site Tour</td>
<td>October 8, 2016</td>
<td>Est. 45-50 Attendees</td>
</tr>
<tr>
<td>Stakeholder Meeting</td>
<td>October 8, 2016</td>
<td>2 Property Owners</td>
</tr>
<tr>
<td>Kitchen Table Meeting #1</td>
<td>November 7, 2016</td>
<td>5 Attendees</td>
</tr>
<tr>
<td>Kitchen Table Meeting #2</td>
<td>November 29, 2016</td>
<td>5 Attendees</td>
</tr>
<tr>
<td>Stakeholder Meeting</td>
<td>April 3, 2017</td>
<td>2 Property Owners</td>
</tr>
<tr>
<td>Stakeholder Meeting</td>
<td>April 3, 2017</td>
<td>2 Property Owners</td>
</tr>
<tr>
<td>Stakeholder Meeting</td>
<td>April 12, 2017</td>
<td>2 Property Owners</td>
</tr>
<tr>
<td>City Council Presentation</td>
<td>May 22, 2017</td>
<td>Est. 30 Attendees</td>
</tr>
<tr>
<td>Open House</td>
<td>June 13, 2017</td>
<td>Est. 20 Attendees</td>
</tr>
</tbody>
</table>
Targeted Stakeholder Outreach

Stakeholder Meetings
The outreach process included several stakeholder meetings with and email updates to the affected property owners. The purpose of the meetings and emails was to gain a better understanding of stakeholder observations or concerns along the corridor, learn about the history and aspirations of the community, gather their feedback on the design alternatives and their final feedback on the preferred alternative.

Kitchen Table Meetings
The project team has hosted two “kitchen table” meetings, small neighborhood meetings that allow hosts to invite their neighbors, and speak directly with the project team. Emphasis for the meetings was on communication with neighbors and affected property owners. Below are some common comments and questions heard at both meetings:

- Access along the corridor is needed for connectivity
- Large trucks are restricted from using the corridor, but some still do. A truck was stuck at the corner and had to back out.
- Speeding is an issue along the corridor.
- There is very little traffic during the day/outside of rush hour.
- It’s impossible to walk/bike to school.
- Are improvements a forgone conclusion?
- Can the City implement interim / phased solutions?
- What is the construction timeline?
- Can the City change the speed limit?

Community Outreach Meetings
Community outreach meetings attended by the project team included the Ibach Community Involvement Organization’s (CIO) meeting, where the team gave a presentation on the project, answered questions and discussed upcoming opportunities to provide input.

Public & Online Events
Corridor Site Tour
With support and traffic control provided by the City, the project team closed the street for two hours to let people walk and bike the corridor. This open streets-style event drew many long-time residents who were excited to walk the corridor for the first time in many years. The project team provided information on the width of the right of way and pointed out specific challenges of the site. The following summarizes the types of comments collected during the event:

- Safety seemed to be the main concern, over traffic congestion.
- Speed is a major concern. Project should do something to reduce speeding.
- Corridor is unsafe for pedestrians.
- Corridor is used as a cut through for N-S traffic due to congestion on alternative routes.
- Providing a separate space for people biking and walking along the corridor is a big priority.
- The corridor lighting needs to be improved.
Project Website
A project website was developed as a simple site within the City of Tualatin’s website: www.gardencornercurves.com. The site features elements such as background documents, project timeline, calendar, photos/slideshow, project tour video, meeting minutes, online survey, email list, FAQ, and project team contact information.

Virtual Corridor Video Tour
The project team enlisted a professional drone pilot to help prepare a video tour of the corridor. The video, which features a flyover of the corridor, pauses at key locations to highlight opportunities and constraints. The video is featured on the project website and YouTube. This video was useful throughout the project, as a reference during the alternatives development phase.

Online Surveys
Using Survey Monkey, the project team created two online surveys. The first was live during the listening phase and asked questions about the corridor’s safety for pedestrians, bicyclists, and motorists. 183 people responded to the survey. The second survey was live for four weeks after the open house and asked questions about specific traffic calming treatments, and about key elements of each design alternative. 103 community members responded. Respondents were allowed to like multiple options, nearly 70% preferred Option A, just over 45% liked Option B, nearly 50% liked Option C, and less than 40% liked Option D. Summaries of both surveys can be found beginning on the next page this memo.

Open House
An Open House was held June 13th, 2017 at the Tualatin High School. The team led a brief presentation on the key differences between the four design alternatives and then broke into small groups (one for each alternative) and took notes as community members shared their thoughts about each design alternative. Below are some common comments and questions heard at both meetings:

- Several people were concerned about speeding, and would like to see speed humps and other speed reduction strategies implemented widely through the corridor – regardless of the option.
- Several people mentioned that they would like to see an option that accommodated future trail connection to Ibach Park. Several people discussed using the informal trail through this area.
- There were a few discussions weighing the benefits of bike lanes versus a shared use path. General consensus was in favor of the shared use path as a means to accommodate all levels of users (as long as it’s wide enough).
- Several people were concerned that school children couldn’t bike or walk to school.
- Several people were concerned about the general safety through the corridor, sight distance at the corners (specifically at 105th and Blake), and being able to make those corners without having oncoming traffic to contend with. They also wanted someone to do some vegetation maintenance along Hedges Creek.

Design Alternatives Video Tour
The project team modeled 3 of the design alternatives and superimposed the designs over the video to illustrate how the different options would fit within the corridor. The video pauses at key locations to
show various safety improvements. The video is featured on the project website and YouTube and was provided as a link along with the online survey to help capture feedback from community members who weren’t able to attend live public meetings.

Summary of Online Survey #1

**How close do you live or work to the corridor? (check one)**

- Immediately adjacent
- In one of the adjoining neighborhoods
- Outside of the immediate area

**How do you usually travel on the corridor? (check all that apply)**

- I don’t travel on the...
- By car
- By foot
- By bike
How often do you travel on the corridor? (check one)

Daily or every weekday: 60.0%
Once a week: 20.0%
Once a month: Less than 10.0%
A few times per year: Less than 10.0%
Once a year: 10.0%
Never: 10.0%

When do you usually travel on the corridor? (check one)

Weekdays during peak travel times (7am-9am or 4pm-6pm): 60.0%
Weekdays not during peak travel times: 20.0%
Weekends: Less than 10.0%
Varies: 10.0%
Do you agree with the following statement? (check one)“When I am walking or riding a bike, there are safe and convenient alternative routes other than the corridor that I can use to get where I want to go.”

Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

Do you agree with the following statement? (check one)“When I am driving, there are safe and convenient alternative routes other than the corridor that I can use to get where I want to go.”

Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree
There is an existing flasher system at each end of the corridor, do you understand what it's used for?

- It's there to tell people where to cross the street.
- It's there to tell drivers that people are walking or biking in the roadway.
- I don't know why it's there.
- I am not aware of the flasher system.

Does the corridor feel safe to you when walking?

- Yes
- No
Does the corridor feel safe to you when driving or riding in a car?

- Yes: 20.0%
- No: 80.0%

Does the corridor feel safe to you when riding a bicycle?

- Yes: 0.0%
- No: 100.0%
What do you think are the biggest safety concerns on this corridor? Ranks the following concerns from 1 to 10, with 1 being the lowest concern. (Using simple averages)

- Existing flashing light system is inadequate
- No adequate facilities for people biking
- No sidewalk for people walking
- People not stopping for pedestrians in marked or unmarked crosswalks
- People tailgating
- The curvy nature of the roadway
- People texting while driving
- Low lighting levels
- Blind corners or limited visibility
- People speeding in cars

Do you agree with the following statement? (check one) “It is important that the corridor is made safer for driving.”

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree
Do you agree with the following statement? (check one) “It is important that the corridor is made safer and more comfortable for walking.”

Do you agree with the following statement? (check one) “It is important that the corridor is made safer and more comfortable for bicycling.”
Considering other potential traffic safety and improvement needs throughout Tualatin, how important is it to improve this corridor? (check one)

- Very low priority: 0.0%
- Low priority: 20.0%
- Neutral: 40.0%
- High priority: 40.0%
- Very high priority: 10.0%

How close do you live or work to the corridor? (check one)

- Immediately adjacent: 10.00%
- In one of the adjoining neighborhoods: 70.00%
- Outside of the immediate area: 20.00%
How do you use the corridor today?

- Drive: 100.00%
- Walk: 10.00%
- Bike: 20.00%
- Run: 40.00%
- I don't use the corridor: 60.00%
- Other (please specify): 80.00%

What type of vehicle do you typically drive in the corridor?

- Passenger car: 100.00%
- Commercial truck: 80.00%
- Bus: 60.00%
- Bicycle: 40.00%
- Motorcycle: 20.00%
- Other (please specify): 0.00%
How will you use the corridor after the project is complete?

Responses

Drive
Walk
Bike
Run
Other (please specify)

Do you use the corridor for the following? (check all that apply)

Responses

Commuting to/from work or school
Recreation
Travel to/from home
Travel to/from another person's home
The next several questions asked respondents to indicate their preferences for a variety of traffic calming treatments:

**Speed humps** (reduces speed through driver discomfort - see image below)

<table>
<thead>
<tr>
<th>Preference</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like</td>
<td>45.00%</td>
</tr>
<tr>
<td>Dislike</td>
<td>35.00%</td>
</tr>
<tr>
<td>Indifferent</td>
<td>20.00%</td>
</tr>
</tbody>
</table>

**Speed feedback display sign** (reduces speed through driver awareness - see image below)

<table>
<thead>
<tr>
<th>Preference</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like</td>
<td>60.00%</td>
</tr>
<tr>
<td>Dislike</td>
<td>10.00%</td>
</tr>
<tr>
<td>Indifferent</td>
<td>30.00%</td>
</tr>
</tbody>
</table>
Stop signs at SW 108th and SW Blake St

Raised bike lanes (raises people biking out of the roadway - see image below)
Some other common suggestions for traffic calming treatments included:

- A middle island with plants
- A buffer between the road and sidewalk
- Colored paint/ art on sidewalk
- Glow in the dark paint and lighting at night
- Raise the road to improve visibility around the curve
- Additional Stop signs and or speed bumps on 108th at Willow
- During winter snow, becomes icy and dangerous and not able to drive nor walk. Need some type of surface to let snow melt faster or improve road traction
- Protection guards between pedestrians and autos, shared lane markings for cyclists and cars instead of designated bike lanes, landscape planter designs prior to entering corner at both ends, relocating reduced speed limit signs, removing 30 mph sign in corridor
- Lower speed on Ibach St. Across from the park. 30mph is more than fast enough. Tons of kids around. No reason it should be 35!
- Can’t remember if every option had a yellow line for the middle of the road. That would be helpful on the corners.
Next the respondents were asked about their preferences for the four design alternatives and then several features unique to each option. The following are their responses:

Option A – East Shared Use Path

![Bar chart showing responses to option A](chart1)

How do you feel about option A?

Responses

![Bar chart showing responses to East side shared use path](chart2)

East side shared use path

Responses
Crosswalk at corner of 108th and Blake

Responses

Landscape planter to protect corner

Responses
Cobbled surface to warn bicyclists of pedestrian mixing

Responses

Left turn pocket for bicyclists at 105th

Responses
Rectangular Rapid Flashing Beacons (RRFBs)

Landscape buffer in the curves
Raised crosswalk at 108th and Willow

Responses

Like
Dislike
Indifferent

Stormwater planter with trees to protect corner

Responses

Like
Dislike
Indifferent
Cobbled surface to warn cyclist of pedestrian merge

- Like: 60.00%
- Dislike: 20.00%
- Indifferent: 20.00%

Speed hump on Blake

- Like: 30.00%
- Dislike: 45.00%
- Indifferent: 25.00%
Left turn pocket for bikes at 105th

Rectangular Rapid Flashing Beacons (RRFBs)
Option C – Sidewalk and Bike Lanes

How do you feel about option C?

East side sidewalk
East bike lane

- Like: 60.00%
- Dislike: 20.00%
- Indifferent: 20.00%

West buffered bike lane

- Like: 60.00%
- Dislike: 30.00%
- Indifferent: 10.00%
Digital speed feedback sign (see image below)

- Like: 60.00%
- Dislike: 20.00%
- Indifferent: 20.00%

Raised Crosswalk (see image below)

- Like: 60.00%
- Dislike: 20.00%
- Indifferent: 20.00%
Raised bike lanes at corners for protection (see image below)

Like Dislike Indifferent
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00%

Responses

Textured treatment before raised bike lane to warn cyclist of tight

Like Dislike Indifferent
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00%

Responses
Option D – Sidewalks and Bike Lanes on Both Sides

How do you feel about option D?

Rectangular Rapid Flashing Beacons (RRFBs)

Responses

Like

Dislike

Indifferent

Responses
Sidewalks on both sides

Buffered bike lanes both sides
Stop signs at 108th and Blake

Like: 0.00%
Dislike: 60.00%
Indifferent: 20.00%

Crosswalk at 108th and Blake

Like: 50.00%
Dislike: 30.00%
Indifferent: 10.00%
APPENDIX E: SCHEMATIC DESIGN ALTERNATIVE GRAPHICS
**Option A - East Shared Use Path**

City of Tualatin

Garden Corner Curves

- **108th Avenue** & Blake Street
  - Standard Cross Section
  - 35.5' Wide Minimum Paved Width
  - 10' Travel Lane
  - 10' Travel Lane
  - 2' Shoulder
  - 5' Sidewalk
  - 5' Bike Lane

- **108th Avenue** with RRFB
  - Painted Transition To On-street Bike Lanes
  - 12' Wide Shared Use Path

- **105th Avenue Intersection**
  - Potential Stormwater Facility

- **105th Ave Corner**
  - Right of Way Impacts

- **Ibach Park**
  - Possible Stormwater Facility
  - Large concrete tree planters

- **Willow St & Gardner Corner Nursery**

- **Hedges Creek**
  - Potential Impact

- **Existing Wetland Impacts** will Require Mitigation

**Tri-County Industrial Park**

**Future Ibach Park Connection** (Alignment TBD)

**Existing Wall to Remain**

**Chain Link Fence**

**Approximate Existing Roadway Limits**

**Culvert Modifications**

**Douglas Fir**

- 36" Potential Impact
- 30" Potential Impact
- 28" Potential Impact
- 24" Likely Impact

- **Maple**
  - 15" Likely Impact
  - 18" Likely Impact
  - 18" Likely Impact
  - 12" Removed
Option B - West Shared Use Path

City of Tualatin

Garden Corner Curves

WE:1427A                                           April 27, 2017

35.5' Wide Minimum Paved Width
10' Travel Lane
10' Travel Lane
2' Shoulder
12' Shared Use Path
1' Shoulder
105th Avenue, Blake Street and 108th Avenue

Standard Cross Section

108th Ave
105th Ave
Blake St

108th Ave/ Willow St Intersection

105th Ave Intersection

Tri-County Industrial Park

108th Ave Corner

105th Ave

12' Wide Shared Use Path
(Cobbled Texture at Corner)

Painted Transition
To On-street Bike Lanes

Painted Transition
From On-street Bike Lanes

RRFB

12' Wide Shared Use Path

12' Wide Shared Use Path

12' Wide Shared Use Path

Per City Code, roadway improvements within City park property require public vote for approval.

Possible Stormwater Facility

Possible Stormwater Facility

Possible Stormwater Facility

Existing Wall to Remain

Existing Wall to Remain

Hedges Creek

Possible Stormwater Facility

Possible Stormwater Facility

Possible Stormwater Facility

Culvert Modifications

Retaining Wall

Retaining Wall

Chain Link Fence

Approximate Existing roadway limits

36" Douglas Fir

Likely Impact

36" Douglas Fir

Impact Potential

30" Douglas Fir

Likely Impact

12" Maple

Likely Impact

28" Douglas Fir

Potential Impact

15" Douglas Fir

Likely Impact

18" Maple

Likely Impact

24" Douglas Fir

Likely Impact

24" Douglas Fir

Likely Impact

24" Douglas Fir

Likely Impact

24" Douglas Fir

Likely Impact

Existing Wetland Impacts will Require Mitigation
Option C - Sidewalk and Bike lanes
City of Tualatin
Garden Corner Curves

WE:1427A                                           April 27, 2017

37.5' Wide Minimum Paved Width
10' Travel Lane
10' Travel Lane
5' Bike Lane
2' Buffer (Optional Flexible Delineator)

105th Avenue and Blake Street
Standard Cross Section
5' Bike Lane
5' Sidewalk

Corner Treatment at Intersection of Blake Street and 108th Avenue
Standard Cross Section
5' Raised Bike Lane / Cycle Track
5' Sidewalk

108th Avenue
Standard Cross Section
5' Bike Lane
5' Sidewalk

5' Wide Raised Cycle Track
5' Wide Sidewalk
Pedestrian Ramp

Per City code, roadway improvements within city park property require public vote

Tri-County Industrial Park
Willow St
Garden Corner Nursery
Ibach Park

Existing Wall to Remain
Hedges Creek Trees
Future Ibach Park Connection (Alignment TBD)
Retaining Wall
Chain Link Fence
Approximate Existing Roadway Limits
Culvert Modifications
30" Douglas Fir Likely Impact
12" Maple Likely Impact
36" Douglas Fir Potential Impact
28" Douglas Fir Potential Impact
15" Douglas Fir Likely Impact
18" Douglas Fir Likely Impact
18" Maple Removed
24" Douglas Fir Likely Impact
36" Douglas Fir Potential Impact
12" Maple Potential Impact
24" Douglas Fir Potential Impact
36" Douglas Fir Potential Impact
12" Maple Potential Impact

Existing Wetland Impacts will Require Mitigation

Option C - Sidewalk and Bike lanes
City of Tualatin
Garden Corner Curves

108th Ave Corner

RRFB Concrete Speed Table and Crosswalk
Cobbled/Textured Visual Treatment prior to corner

5' Wide Raised Cycle Track
5' Wide Sidewalk
Pedestrian Ramp

Right of Way Impacts
Option D - Sidewalk and bike lanes - both sides

City of Tualatin
Garden Corner Curves

WE:1427A                                           April 27, 2017

41.0' Wide Minimum Paved Width
10' Travel Lane
10' Travel Lane
5' Bike Lane
5' Sidewalk
5' Bike Lane
5' Sidewalk
2' Buffer (Optional Flexible Delineator)
2' Buffer (Optional Flexible Delineator)

45.0' Wide Minimum Paved Width
10' Travel Lane
10' Travel Lane
5' Bike Lane
5' Sidewalk
5' Bike Lane
5' Sidewalk
2' Buffer (Optional Flexible Delineator)
2' Buffer (Optional Flexible Delineator)

Roadway improvements within park property require popular vote for approval.

Future connection to Ibach Park. Location TBD.

Possible Stormwater Facility

Hedges Creek
Roadway widening to the west of 105th avenue will have significant impacts on Hedges Creek.

Existing Wetland Impacts will Require Mitigation
APPENDIX F: INTERIM IMPROVEMENTS MEMORANDUM
The Garden Curves corridor consists of three narrow roadways within the City of Tualatin – SW 108th Avenue, SW Blake Street, and SW 105th Avenue. The corridor does not currently meet the City’s street design standards (as defined in their Public Works Construction Code). In addition, the corridor presents numerous safety and access concerns for vehicles, pedestrians, and bicyclists. In order to address these concerns, the City is completing the Garden Curves Concept Study for the corridor with Wallis Engineering and Alta Planning + Design.

As part of the concept study, a number of interim improvements are possible to improve conditions within the corridor. The goal of interim improvements is to provide short-term solutions that could increase visibility, reduce motorist speeding, and improve overall safety for pedestrians, bicyclists, and motorists. Some or all of these improvements could be implemented prior to the larger-scale improvement alternative selected by the public and the City in the corridor study. Alternatively, these improvements could be implemented as an alternative to the larger-scale improvements.

The purpose of this memorandum is to describe a number of potential interim improvements with respect to their advantages, disadvantages, and applicability to the corridor.

INTERIM IMPROVEMENTS

The location of each interim improvement is shown on the attached Exhibit A, and designated with a numerical callout and the type of improvement. Each improvement is discussed briefly in the following paragraphs.
1. **Pavement Markings at Corners (transverse markings or optical speed bars)**

Transverse markings or optical speed bars could be added at corners in order to provide additional visual delineation. An example of this type of application is shown to the right as Figure 1. These types of pavement markings have proven to be effective in speed reduction at corners for similar types of roadways.

2. **Rumble Strips at Centerline**

Rumble strips could be added at the centerline of the roadway, either for the entire roadway or at the corners in particular. An example is shown to the right in Figure 2. This type of treatment has moderate efficacy for reducing lane crossover, and could therefore improve safety. It should be noted that this treatment is most applicable to roadways experiencing crossover accidents – which is not the case for this corridor. Because rumble strips discourage motorists crossing the centerline, they may result in unsafe passing maneuvers (for motorists passing bicyclists). It should also be noted that this improvement is not typical for lower speed roadways, and would likely increase the noise level of the roadway.

3. **Removal of existing centerline striping**

The existing centerline striping along the corridor could be removed as a speed reduction strategy. A local example on a residential street is shown to the right in Figure 3. This improvement has been found to result in reduced vehicle speeds for narrow roadways, so it would be an effective improvement. It should be accompanied with signage warning drivers that the road narrows. Given the constrained roadway, it might be warranted to maintain the centerline along sections of roadway with curves and low visibility. Centerline removal has the disadvantage as being perceived as “unsafe” to the general public, particularly in an established roadway with poor lighting and visibility limitations.

4. **Sign Placement Improvements**

Currently, signs within the corridor are often in areas with poor visibility, or obscured by vegetation. Sign relocation and/or replacement for optimal visibility is a simple, inexpensive, improvement which could help to improve safety throughout the corridor.

5. **Speed Feedback Display Sign**

A speed feedback display sign could be installed prior to curves or areas where motorists are observed to drive to fast. An example of this sign is shown to the right as Figure 4. This improvement could consist of a temporary display sign, or permanent post-mounted sign. Speed feedback display signs have been proven to reduce speeds in similar types of roadways in a number of applicable studies, and are effective long-term in reducing speeds (for permanent sign installations).
6. **Chevron Signs**
Currently, the chevron installations at both curves in the corridor are substandard. The safety concerns associated with these corners warrant the addition of multiple chevron signs - especially at the corner of SW 108th Ave and SW Blake St. The addition of more chevron signs would provide a more striking visual delineation of the roadway, and be more typical of sharp corners than the current signage. Multiple signs have the potential to reduce speeds and improve safety at the corner. Furthermore, this is a relatively inexpensive and simple improvement.

7. **Improvements to Existing Warning Signal System**
There are a number of potential improvements to the existing warning signal system which could improve the system’s efficacy and safety within the corridor. These improvements will be described in more detail in a technical memorandum to the City.

8. **Slope Benching for Visibility**
The corner at SW 105th Ave and SW Blake St has a steep embankment which limits visibility of the roadway. There appears to be adequate public Right-of-Way available for a bench to be cut into the embankment to improve sight distance at this corner. This is a relatively inexpensive improvement that could improve safety at this location.

9. **Lighting Improvements**
Improvements to lighting along the roadway corridor could greatly improve visibility and safety for all users. These improvements could consist of replacement of existing luminaires and/or addition of additional lighting along the roadway.

10. **Anti-speeding Public Awareness Campaign**
The implementation of an anti-speeding public awareness campaign could greatly improve safety within the corridor through speed reduction. This speed reduction strategy has proven long-term effectiveness, and is most applicable for neighborhoods with a strong sense of public involvement and community. Though the short-term effects of this strategy are not substantial, long-term effects are significant. This strategy could be combined with police enforcement to improve short-term effectiveness.

11. **Shared Lane Markings – ‘Sharrows’**
Currently, bicyclists have no separated facility through the corridor, but often travel within the roadway lanes. Sharrows and associated signage could be added to the roadway pavement to provide specific direction and guidance to both bicyclists and vehicles to share the road. Sharrows are applicable to roadways with speed limits of no more than 35 mph. An example of this pavement marking is shown to the right as Figure 6.

12. **Stop Signs**
The intersection of SW 108th Avenue and SW Blake Street could be converted to a stop-sign controlled intersection in order to address safety concerns at this intersection. There have been a number of car crashes at this intersection in which speeds in excess of the 15 mph advisory speed were likely a factor. It should be noted that stop signs have not been found to be an effective speed reduction strategy, and per the MUTCD, stop signs are not permitted as a speed reduction measure. It should also be noted that the addition of stop signs at this location would likely have negative implications for roadway noise.
13. Dashed Bike Lane (Advisory Bike Lane)

The City may also consider the removal of the centerline striping and installation of edge markings to create a dashed bike lane. Per FHWA, preliminary findings on this application have been mixed. Experimentation to date has discovered that this application can achieve public acceptance and generally be advantageous only where many or all of the following conditions are present:

- Traffic volume is less than 6,000 ADT.
- Minimum lateral width of 16 feet of the center space between dashed bicycle lanes.
- The street is not a designated truck or bus route, nor would the street be expected to facilitate these vehicle types to and from other facilities.
- The dashed bicycle lanes (for both directions) are not installed to a street that is interspersed in an overall one-way street network, grid, or area.

14. Speed Humps

Speed humps could be added to straight segments of the road as a speed reduction measure. Speed humps are a proven speed reduction strategy. However, it should be noted that speed humps should not be placed within certain distances of curves and corners, and are not suitable for roadways with grades greater than eight (8) percent – this excludes a large portion of the corridor from receiving speed humps. It should also be noted that speed humps should not be used on major collectors or primary emergency response routes because they slow down emergency response vehicles. The addition of speed humps to existing streets is the source of strong public opinion – both for and against this speed reduction measure. There is also the possibility of an increase in traffic noise resulting from braking and acceleration of vehicles before and after encountering a speed hump.
Exhibit A: Interim Improvements
City of Tualatin
Tualatin Garden Corner Curve Concept Study

Legend
1. Pavement markings at corners
2. Rumble strips centerline
3. Removal of existing centerline striping
4. Sign placement improvements
5. Speed feedback display sign
6. Chevron signs
7. Improvements to existing warning signal system
8. Slope benching for visibility
9. Lighting improvements
10. Anti-speeding public awareness campaign
11. Shared lane markings - 'sharrows'
12. Stop Signs
13. Dashed Bike Lane
14. Speed humps
**Preferred Alternative**

East Shared Use Path

- 108th Ave
- Cobble Texture with striping to maintain pedestrian and bicycle separation
- 5' Sidewalk
- Pavement marking to separate pedestrian and bicycle traffic

- 5' Sidewalk
- Connection to proposed Helenius Greenway

- Raised Crossing
- Double-Yellow Striping
- Bicycle Crossing with RRFB
- Painted Transition To On-street Bike Lanes

- 12' Wide Shared Use Path

- Driveway
- Slopes

- 108th Ave Corner
- 105th Ave Intersection
- 105th Ave
- Blake St
- Future Ibach Park Connection (Alignment TBD)

- Large concrete tree planters
- Right of Way Impacts
- Existing Wall to Remain
- Existing Wetland Impacts will Require Mitigation

- Digital Speed Feedback Display Sign
- Possible Stormwater Planter

- Tri-County Industrial Park
- Willow St
- Garden Corner Nursery
- Ibach Park
- Chain Link Fence
- Retaining Wall

- Culvert Modifications
- 36" Douglas Fir Potential Impact
- 30" Douglas Fir Potential Impact
- 24" Douglas Fir Potential Impact
- 12" Maple Potential Impact
- 28" Douglas Fir Potential Impact
- 15" Douglas Fir Likely Impact
- 24" Douglas Fir Likely Impact
- 18" Douglas Fir Likely Impact
- 18" Maple Removed
APPENDIX H: OPINION OF COST
## Preferred Option - Tualatin Garden Curves Improvements

### Project Summary

City of Tualatin Garden Corner Curve Concept Study Opinion of Cost  
Prepared by Wallis Engineering, JAK  
WE #1427A

<table>
<thead>
<tr>
<th>PROJECT WORK ITEMS</th>
<th>COST</th>
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<tr>
<td>Temporary Traffic Control [4]</td>
<td>$45,840</td>
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<tr>
<td>Erosion/Sediment/Pollution Control Plan [5]</td>
<td>$22,920</td>
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<tr>
<td>Clearing and Grubbing [7]</td>
<td>$15,280</td>
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<tr>
<td>Project Component - Roadway Improvements (See Page A2)</td>
<td>$908,117</td>
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<tr>
<td>Project Component - Stormwater Facilities (See Page A3)</td>
<td>$619,840</td>
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</table>

### Construction Subtotal

| Total Construction Cost | $1,781,602 |

### Total Right-of-Way

| Right-of-Way (Total: 2,834 SF) | $32,050  |
| Right-of-Way Services ($15,000 per parcel) | $30,000  |
| Right-of-Way Contingencies: 40% | $12,820  |

### Total Right-of-Way

| Total Right-of-Way | $74,870  |

### Total Engineering & Administration

| Design Engineering & Administration: 15% | $347,415  |
| Permitting: 5%                          | $115,805  |
| Construction Engineering Services: 12%  | $277,935  |

### Total Engineering & Administration

| Total | $741,155  |

### Total

| Total | $3,132,112 |

---

### Project Notes and Assumptions

1. See attached Pages A2-A4 for detailed cost breakdowns and assumptions specific to each project component.
2. Estimated costs assume construction, Right-of-Way acquisition, engineering and administration completed per federal funding requirements.
3. Mobilization is assumed to be 10% of the total of all project component costs.
4. Temporary Traffic Control is assumed to be 3% of the total of all project component costs.
5. Erosion and Sediment Control, Pollution Control Plan is assumed to be 1.5% of the total of all project component costs.
6. Removal of Structures and Obstructions is assumed to be 0.5% of the total of all project component costs.
7. Clearing and Grubbing is assumed to be 1% of the total of all project component costs.
**APPENDIX H**

**Preferred Option - Tualatin Garden Curves Improvements**

**Project Component: Roadway Improvements**

<table>
<thead>
<tr>
<th>Project Component</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Total</th>
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<tbody>
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<td>TONS</td>
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<td>SY</td>
<td>$60.00</td>
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<td>Porous Concrete Walk</td>
<td>1,969</td>
<td>SY</td>
<td>$70.00</td>
<td>$137,814</td>
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<td>Curb and Gutter</td>
<td>2,250</td>
<td>LF</td>
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<tr>
<td>Roadway Excavigation</td>
<td>2,015</td>
<td>CY</td>
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<td>1,070</td>
<td>SF</td>
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<td>MSE Wall</td>
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<td>$100.00</td>
<td>$128,000</td>
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<td>4' Chain Link Fence</td>
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<td>Wetland Mitigation</td>
<td>1,500</td>
<td>SF</td>
<td>$5.00</td>
<td>$7,500</td>
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**Project Component Subtotal:** $908,117

**Project Component Assumptions**
1. The roadway area value was determined assuming that existing pavement will remain wherever possible.
2. Roadway excavation quantities are assumed equal to the product of the surface area of the improvements by the depth, with additional volume added to account for roadway grade changes. Depth is assumed to be the distance between the top of finish grade and the top of subgrade.
3. Street lighting was assumed to consist of mid-range cobra head style LED lights on new poles.
4. Wetland mitigation includes a 5 foot wide area along approximately 300 feet of SW 105th Ave, south of SW Paulina Dr.
5. Porous concrete assumed for sidewalk and shared use path.
## APPENDIX H

**Preferred Option - Tualatin Garden Curves Improvements**

**Project Component: Stormwater Facilities**

<table>
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<tr>
<th>Component</th>
<th>Quantity</th>
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<td>10</td>
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<td>Rain Garden 1 Surface Area (SF)</td>
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<td>Rain Garden 2 Length (FT)</td>
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<td>Rain Garden 2 Width (FT)</td>
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<tr>
<td>Rain Garden 2 Surface Area (SF)</td>
<td>480</td>
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### Construction Subtotal: $619,840

**Project Component Assumptions**

1. The new and replaced impervious area for the project is assumed to be 22,821 SF, requiring 1400 SF of stormwater facilities. This area was calculated assuming that sidewalks will be porous.
2. With a constant width, the length of the rain gardens may vary depending on right-of-way acquisition and the final road elevation.
3. Depending on the final surface area of the rain garden, and the area of additional on-site stormwater facilities, a supplemental underground detention structure may be required.
4. Culvert construction includes installation of a 15 foot span by 9 foot rise reinforced concrete box culvert, with channel realignment. A detailed cost estimate is included in the Conceptual Culvert Design Memorandum.
5. Water quality facility plantings are assumed for approximately 90% of the rain garden area.
# APPENDIX H

**Preferred Option - Tualatin Garden Curves Improvements**

**SW 105th Ave/Blake St/108th Ave**

**Right-of-Way Acquisition**

<table>
<thead>
<tr>
<th>Work Item</th>
<th>Quantity</th>
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<td>3,205</td>
<td>SF</td>
<td>$10.00</td>
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Total Cost of ROW Acquisition: $32,050.00

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<thead>
<tr>
<th>Address</th>
<th>Length of Frontage (ft)</th>
<th>Acquisition (SF)</th>
<th>Notes/Assumptions</th>
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<tr>
<td>21550 SW 108th Ave, Tualatin</td>
<td>See area</td>
<td>505</td>
<td>3’ offset from back of curb</td>
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<td>10665 SW Blake St, Tualatin</td>
<td>See area</td>
<td>2700</td>
<td>5’ offset from back of retaining wall</td>
</tr>
</tbody>
</table>

Total ROW Acquisition Area (SF) 3205

Assume no ROW required for wetland mitigation.
APPENDIX I - REFERENCES

1. NW Natural Map Plat ID 1-052-018
2. Water Master Plan prepared for City of Tualatin, Oregon, January 2013, Amended July 2013, prepared by MSA and FCS Group
3. Tualatin Sewer master Plan prepared for City of Tualatin, December 2002 by CH2M Hill
5. Revised Tualatin Transportation System Plan Update prepared for City of Tualatin, Updated February 2014, prepared by CH2M Hill
6. Tualatin Street Design Standards
8. Oregon Department of Transportation – Transportation Development Division – Transportation Data Section – Crash Analysis and Reporting Unit, Urban Non-System Crash Listing for 105th Ave and Intersectional Crashes at 105th Ave, City of Tualatin, Washington County, 01/01/2011 to 12/31/2015
9. Oregon Department of Transportation – Transportation Development Division – Transportation Data Section – Crash Analysis and Reporting Unit, Urban Non-System Crash Listing for 108th Ave and Intersectional Crashes at 108th Ave, City of Tualatin, Washington County, 01/01/2011 to 12/31/2015
10. Oregon Department of Transportation – Transportation Development Division – Transportation Data Section – Crash Analysis and Reporting Unit, Urban Non-System Crash Listing for Blake St and Intersectional Crashes at Blake St, City of Tualatin, Washington County, 01/01/2011 to 12/31/2015
13. Technical Memorandum Constraints and Opportunities; SW 105th/Blake Street/SW 108th Concepts Study; City of Tualatin, prepared for City of Tualatin by CH2M Hill, March 8, 2012.
14. City of Tualatin Natural Resource Inventory and Local Wetlands Inventory "Off-Site Option", prepared for City of Tualatin by Fishman Environmental Services, December 1995.