City of Bend: Murphy Road – Segment 2 Preliminary Design Memorandum

PREPARED FOR: City of Bend

PREPARED BY: CH2M HILL

DATE: October 7, 2009

Introduction

This design memorandum documents the preliminary design work performed for Segment 2 of the Murphy Road Corridor. It provides the background information on roadway and drainage design, along with utility information. Cost estimates based on quantities generated from the preliminary design are also included. Technical drawings showing the scope and limits of the project are attached to the report.

Due to significant reductions in transportation capital improvement project (CIP) revenues and the need to re-prioritize CIP expenditures, plans to advance some elements of the Murphy Road corridor to construction have been deferred for several years.

For ease of discussion and to define work efforts, we have divided the Murphy Road project corridor into three segments. CH2M HILL completed the *Murphy Corridor Refinement Plan* in 2008, which included developing alternatives for improvements to Murphy Road from Parrell Road to 15th Street. These limits constitute Segments 2 and 3 of the corridor. Separate design memorandums have been prepared for Segments 1 and 3. Segment 1 describes the new alignment of Murphy Road from Brookswood Boulevard over the Bend Parkway and east to Parrell Road. Segment 3 describes the new alignment of Murphy Road from Brosterhous Road to 15th Street.

Project Description

Segment 2 encompasses Murphy Road from Parrell Road to Brosterhous Road. This existing segment of the road was studied in the previous phase of the project and several alternatives were evaluated. The preferred alternative advanced includes widening the road to provide a continuous left-turn lane and intersection improvements at Parrell, Country Club and Brosterhous Roads. Roundabouts are the preferred intersection type that have been developed. Topographic mapping and boundary resolution suitable for preliminary and final design efforts was collected by CH2M HILL for this segment.

This segment is located along the eastern edge of the ODOT lead Interchange Area Management Plan (IAMP) study limits and discussions are underway between the City and ODOT on a work scope to advance and complete the IAMP, which will include refining the design of Murphy Road over the Bend Parkway and east to include the Parrell Road intersection.

Existing Conditions

The land use is residential in Segment 2, with an existing roadway approximatelty 36 feet wide providing a 12 foot travel lane and 6 foot bike lane in each direction. The existing intersections at Parrell Road, Country Club Road and Brosterhous Road are stop controlled for the sidestreet movements. There are gaps in the pedestrian connectivity, with no sidewalks located along much of the segment. The existing right-of-way varies from a minimum width of 60 feet wide and greater in areas with newer development, where additional right-of-way has been dedicated.

The roadway design standards for Segment 2 are defined in Table 1.

TABLE 1
Design Standards

Design Feature	Design Criteria	Source
Classification	Major Collector	City of Bend
Design Vehicle	WB-50 Accommodate WB-67 (tractor-trailer unit with 53 ft. length)	AASHTO, Chapter 2
Design Speed	40 mph	AASHTO, Chapter 6, p.430
Stopping Sight Distance	305' (grade dependent)	AASHTO, Chapter 3, p.110
Minimum KSAG	64	AASHTO, Chapter 3, p.175
Minimum KCREST	44	AASHTO, Chapter 3, p.271
Minimum L	125' (grade difference <1%, grade breaks are allowed)	City of Bend, Design Stds, Section IIA6, p.9
Maximum K	100' (where drainage is a factor)	City of Bend, Design Stds, Section IIA6, p.9
Minimum Horizontal Curvature	R = 675 ft. (normal crown, low speed urban) or 489 ft. @ 4% Max. Superelevation	City of Bend, Design Stds, Section IIA7, p.10
Maximum Grade	8% (10% for hillsides exceeding 15% slope).	City of Bend, Design Stds, Section IIA1, p.2 and 3
Minimum Grade	0.5%	City of Bend, Design Stds, Section IIA2, p.6
Minimum Cross Slope	2.0%	City of Bend, Design Stds, Section IIA3 and 10, p.6 and 11
Maximum Superelevation	6% (4.0% preferred)	City of Bend, Design Stds, Section IIA3, p.6

TABLE 1
Design Standards

Design Feature	Design Criteria	Source
Lane Widths Travel Lanes Center Turn Lane Bike Lanes (2) Sidewalk (2)	 12’ 12’ 6’ 6’	City of Bend, Design Stds, Section IIA1, p.2 thru 5
Right-of-way Width	60’ Minimum. May increase at intersections as stipulated by City Engineer	Project Specific, City of Bend, Design Stds, Section IIA1, p.2
Bike Lanes	Required on all major collectors	City of Bend, Design Stds, Section IIA1, p.2 thru 4
Side slopes	1:1.5 Max (Rock Cut – site specific) 1:2Max	City of Bend, Std Dwg 2-1, Typical Cross Section
Curbs	12-inch standard curb with 6” exposure	City of Bend, Std Dwg 2-3, Sidewalk and Conc. Curbs
Clear Zone	Varies	AASHTO Roadside Design Guide, Chapter 3
Access Management	Driveway Spacing: 22’ (Minimum, bottom of curb drop to bottom of curb drop)	City of Bend, Design Stds, Section IIA11, p.11

Note: All references to American Association of State Highway and Transportation Officials (AASHTO) are for *A Policy on Geometric Design of Highways and Streets, 2004,* unless otherwise noted.

The roundabout design standards for Segment 2 are defined in Table 2.

TABLE 2
Roundabout Design Standards

Design Feature	Design Criteria	Source
Classification	Single Lane Urban	FHWA, Exhibit 1-7
Design Year/Traffic	20 year	City of Bend, Design Stds, Section IIA18, p.21
Design Vehicle	WB-50, Emergency Vehicles shall not be required to use truck apron.	City of Bend, Design Stds, Section IIA18, p.21
Circulating Design Speed	20 mph	FHWA, Exhibit 6-4
Inscribed Circle Diameter	120’ minimum	City of Bend, Design Stds, Section IIA18, p.22

TABLE 2
Roundabout Design Standards

Design Feature	Design Criteria	Source
Entry/Exit Width - Striped	15'/18' (Curb to Curb - 20'/20')	City of Bend, Design Stds, Section IIA18, p.22
Circulating Roadway Width	20'-22'	City of Bend, Design Stds, Section IIA18, p.22
Crosswalks	25' minimum from circulating roadway yield line	City of Bend, Design Stds, Section IIA18, p.22
Splitter Island	25' minimum beyond crosswalk	City of Bend, Design Stds, Section IIA18, p.22
Maximum Approach Grade	4.0%	City of Bend, Design Stds, Section IIA18, p.21
Cross Slope	2.0%	FHWA, Section 6.3.11.2, Exhibit 6-37, p.166
Bike Accomodations: Bike Lane Taper Bike Exit Ramp Multi-use Path	15:1 100' upstream of circulating roadway yield line 10'	City of Bend, Design Stds, Section IIA18, p.22 and 23
Illumination	Shall meet minimum AASHTO's Table 3 in "An Informational Guide for Roadway Lighting" requirements	City of Bend, Design Stds, Section IIA18, p.23
Signing	Shall conform to MUTCD and City of Bend Street Signing Specifications	City of Bend, Std Dwg 2-28, Roundabout Signing

Notes:

All references to FWHA are for *ROUNDABOUTS, AN INFORMATIONAL GUIDE,* 2000, unless otherwise noted.

Roadway Typical Sections

The preliminary plans are attached in Appendix A. The typical roadway width for Segment 2 is 48 feet to provide two 12 foot lanes with 6 foot bike lanes on each side and a continuous left-turn lane.

Variations in the typical section have been discussed for Segment 2, including the suggested use of landscaped medians in place of a continuous turn lane or removing the left-turn lane entirely between Parrell Road and Country Club Road. In the preliminary plans, landscaped medians are shown on Murphy Road between Country Club Road and Brosterhous Road, except at two locations where left-turn lanes are provided. The

landscape medians shown are 8 feet wide from the outside face of curb to outside face of curb and are located within a 12 foot wide lane. This provides 2 feet of shy distance between the 12 foot wide travel lane and the curb, and provides a curb-to-curb passage width of 20 feet (2 foot shy distance + 12 foot travel lane + 6 foot bike lane). No medians are shown along Murphy Road between Parrell Road and Country Club Road, due to the large number of access points along this portion of Segment 2. Bend Fire Department staff have expressed a preference for no medians, as the medians typically restrict their movement and at times reduces their response times and access. Median and left-turn lane locations should be explored further and discussed with adjacement property owners, particularly those with undeveloped land along the roadway. Future site development may alter access points and the desirable location for turn lanes and medians.

Other variations in the typical section that have been discussed include the location of sidewalks. The current design utilizes a sidewalk directly adjacent to the curb. East of Country Club Road where no development has occurred, a sidewalk separated from the curb with a landscaped planter strip may be preferred, to provide a more desirable pedestrian facility. This option should be discussed with property owners.

Intersection Design

Roundabouts have been selected as the intersection form for the Murphy Road intersections with Country Club Road and Brosterhous Road, designed in accordance with the criteria provided in Table 2. A roundabout for the Murphy Road/Parrell Road intersection and is the preferred intersection form, but will be further evaluated with the Segment 1 design concepts for the Murphy Overcrossing as part of the Murphy Overcrossing work plan. The proximity of the Murphy Road/Parrell Road intersection to the signalized Murphy Road/3rd Street intersection requires further review to assess how traffic progression from the signal at 3rd Street will influence operations of a roundabout at Parrell Road.

The ideal design for a roundabout strives to maximize the distance between the legs or approaches to the roundabout, such that for a four leg roundabout, the adjacent legs would be located at 90 degrees to one another. Balancing the design goals with the need to minimize private property impacts, design options were developed during the conceptual design phase for each intersection.

For the Murphy Road/Parrell Road intersection, three concept sketches were developed. There is existing development on all four quadrants of the intersection, so constructing a roundabout at this location will result in some impact to all adjacent property. The objective for this intersection is to develop the roundabout geometry with a location and that would create the fewest number of impacts. The concepts developed evaluated shifting the roundabout north and south of the centerline of Murphy Road, and one concept that centered the roundabout on the existing intersection. These concepts are included in Appendix A. The preliminary plan shows a variation of the concept shifted slightly to the south of the centerline of Murphy Road.. With further refinement of the design, impacts to some properties may be further reduced, perhaps by shifting the roundabout to concentrate more impact to one property. Consideration for access issues will also need to be addressed since driveway closures or relocations at each corner property will need to be determined.

Both the Country Club Road and Brosterhous Road intersections have existing homes built directly adjacent to the north side of Murphy Road. Two concept sketches were developed for both of these intersections. The sketches considered centering the roundabout in the existing intersection or shifting it to the south. These sketches are included in Appendix A. In an effort to minimize impacts to these homes, the proposed roundabouts shown on the preliminary plans at both intersections are shown shifted south. To preserve something close to a 90 degree relationship between the roundabout legs, some shifting and realignment of Murphy Road to the south is proposed. The inscribed circle diameter used for the intersection designs of Country Club Road and Brosterhous Road is 130 feet.

When the design for these intersections is re-started in the future, additional refinements should be explored to further reduce the right-of-way needs.

Traffic Analysis

Traffic analysis for Segment 2 was performed and summarized in the Murphy Corridor Refinement Plan. Detailed analysis is included in Appendix C (Traffic Methodology), Appendix D (Existing Conditions) and Appendix E (Future Conditions and Deficiencies). The intersections were analyzed as signalized intersections, with left turn lanes provided on Murphy Road. A planning level review of roundabouts was also conducted and it was determined that single lane roundabouts would perform well with the anticipated volumes. Detailed operations analysis of roundabouts was not performed and should be completed when the design efforts are advanced in the future.

Horizontal Alignment

The horizontal alignment for Murphy Road in Segment 2 closely follows the existing alignment. The exceptions include the approaches to the roundabouts at Country Club Road and Brosterhous Road and the curve located approximately 800 feet west of Country Club Road, which was flattened slightly to satisfy a 40 mph design speed.

Vertical Alignment

The vertical alignment for Segment 2 closely follows the existing grade of Murphy Road, varying between approximately 0.5 % and 2.5%. For the roadway profile, see Appendix A.

Right-of-Way

The existing right-of-way varies from a minimum width of 60 feet wide and greater in areas with newer development, where additional right-of-way has been dedicated. Existing right-of-way is shown on the preliminary plans. The typical cross section width called for in Table 1 measures 60 feet wide from back of sidewalk to back of sidewalk. Along the corridor, additional strips of right-of-way or easements would be needed to contain the embankment slopes. In many cases, small modular block walls from 1- 4 feet high could be used to minimize the property acquisitions. The more significant right-of-way needs would occur at the intersections, where the roundabouts would require additional property to be acquired in all four quadrants. It does not appear at this time that full acquisitions of any homes at the Country Club and Brosterhous intersections would be necessary. An assessment of impacts should be conducted on the site by a right-of-way appraiser to verify these assumptions. New or proposed right-of-way and easements are not shown on the

preliminary plans and will need to be established once the design is refined and the roadway footprint finalized.

Drainage

A new stormwater conveyance system would be constructed in Segment 2. Two sub basins were defined in Segment 2, with the dividing line located west of Country Club Road. Storm water would be conveyed to a low point in the roadway profile, treated and discharged into drywells. The westerly sub basin low point is located at the intersection with Mel Ct. The facility being proposed at Mel Ct. uses mechanical treatment (Storm Filters) to provide water quality treatment. A mechanical facility is proposed because there is no readily available land for a vegetative facility. This facility is preliminarily sized to treat and dispose of 1.4-ac of the roadway project. The system will be comprised of a 6x12 storm vault with 9 filters, and 15 drywells.

The easterly sub basin low point is located approximately mid-way between Country Club Road and Brosterhous Road. The easterly limits of the drainage subbasin extend into Segment 3, to the crest of the bridge over the BNSF tracks. This facility is preliminarily sized to treat and dispose of runoff from 4-ac of roadway from the project. The proposed system is comprised of an infiltration swale discharging flows above the water quality flow to six drywells. Using a natural water quality facility allows for a reduction of the required volume to be disposed of through the use of drywells. The discharge depth of the storm system in relation to the adjacent land results in a fairly deep facility that will require extensive excavation for construction. The approximate foot print of this facility is shown on the plans.

The design of the storm drainage conveyance system in Segment 2 was done in conjunction with the preliminary design of sanitary sewer improvements proposed along Murphy Road, to accommodate both gravity systems within the street corridor. More details on the storm drainage design are contained in Appendix B.

Utilities

Table 3 shows the utilities, contacts and action needed for future phases of design development for Segment 2:

TABLE 3
Murphy Road Utilities

Utility	Owner	Contact	Action Needed
Water	Roats Water	Casey Roats 61147 Hamilton Lane Bend, OR 97702 541-382-3029	Facilities along Murphy Road. Coordinate facility upgrades along the alignment of Murphy and define and resolve conflicts.
Water	City of Bend		Plans to extend 16" line up Country Club Road to Murphy and east along Murphy Road towards Brosterhous.
Sewer	City of Bend		Existing line to be replaced with new sewer currently under design along the entire length of Segment 2.

TABLE 3
Murphy Road Utilities

Utility	Owner	Contact	Action Needed
Electric	Pacific Power	Mike Bower 328 NE Webster Ave Bend, OR 97701 541-388-7167	Facilities along Murphy Road. Define and coordinate facility relocations along Murphy Road.
Natural Gas	Cascade Natural Gas	Donna Dunlap 3334 NE Hawthorne Ave. Bend, OR 97701 541-382-6465	Facilities along Murphy Road stoping west of the Brosterhous intersection. Define and coordinate conflict resolution.
Communications	Qwest	Bob Kitchen 100 NW Kearney St. Bend, OR 97701 541-385-0224	Qwest has underground facilities in Segment 2, but has not provided information. Obtain facility locations, define and resolve conflicts.
Communications	Bend Broadband	Jeff James 63090 Sherman Road Bend, OR 97701 541-388-5820-3-1 jkjames@bendbroadband.net	Majority of facilities on Pacific Power poles, with some underground. Define and resolve conflicts.

Cost

A preliminary cost estimate was developed for Segment 2, including construction, engineering, administrative and right-of-way costs. A construction contingency of 30 percent is included and the costs are based on 2009 unit cost empirical data with no escalation. Actual project cost will vary depending on year of construction, actual labor and material costs, competitive market conditions, final project scope, and other variable factors.

The estimated construction costs are summarized in the Table below. A detail cost breakdown is included in Appendix C.

TABLE 4

Estimated Construction Costs – Segment 2
(With roundabouts at Country Club and Brosterhous Roads)

Task	Cost
Construction (with contingency)	$5,588,000
Engineering, Administration, Other	$1,118,000
Right of Way	$1,043,000
Total	**$7,749,000**

APPENDIX A

Preliminary Drawings

MURPHY ROAD - SEGMENT 2

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SCALE: 1" = 50' H
1" = 10' V

CH2MHILL

LEGEND

- Existing ROW/Property Lines
- Existing Centerline
- Proposed Curb
- Proposed Retaining Wall
- Proposed Manhole
- Proposed Inlet
- Existing Driveway Closures
- Proposed Cut
- Proposed Fill
- Proposed Sewer Pipe

Segment 2 Vertical Alignment

PROJECT
MURPHY ROAD
SEGMENT 2 - PLAN AND PROFILE

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CH2MHILL

MURPHY ROAD - PARRELL RD & MURPHY RD

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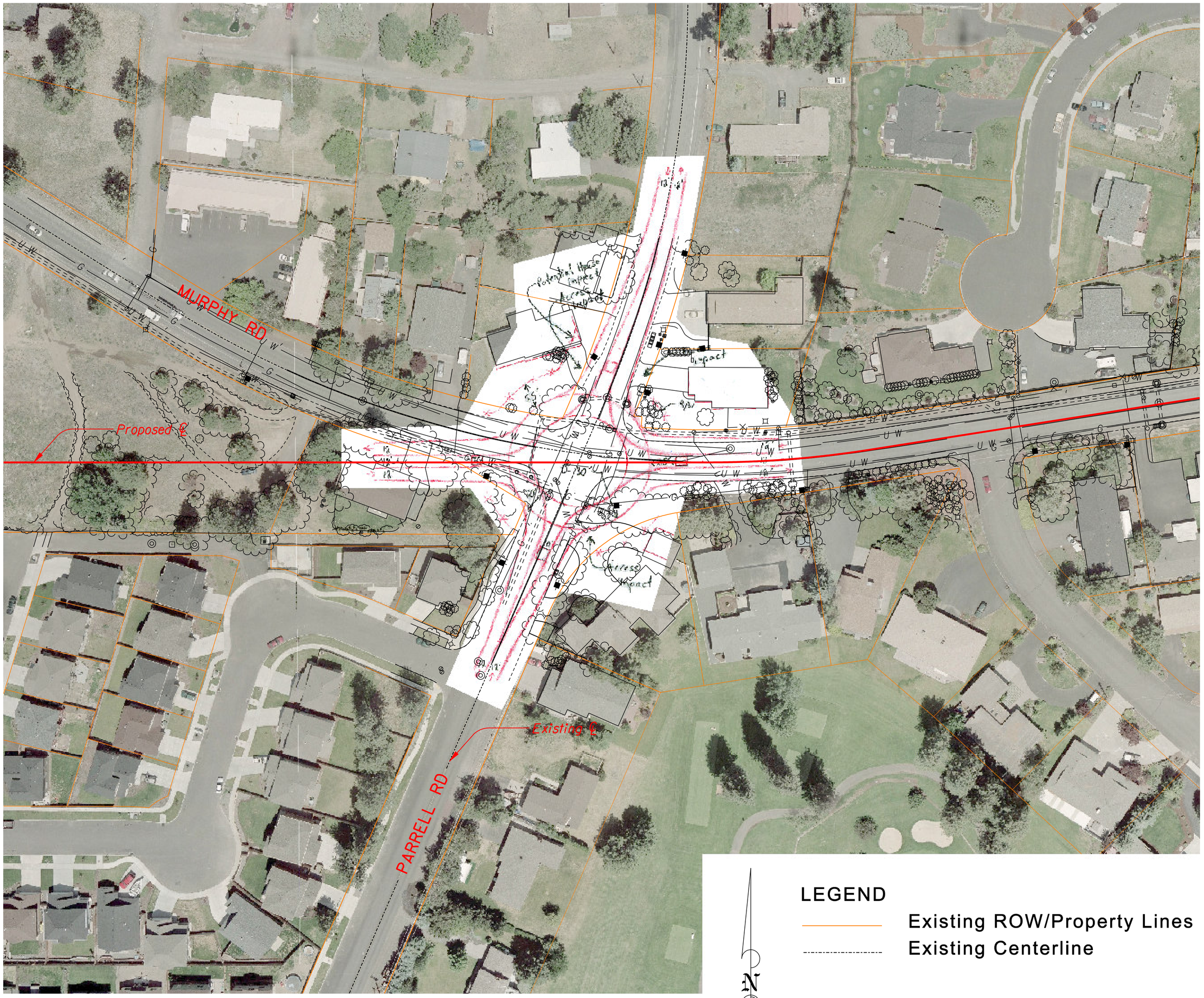

PROJECT

MURPHY ROAD -
PARRELL RD & MURPHY RD INTERSECTION

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CH2MHILL

MURPHY ROAD - PARRELL RD & MURPHY RD

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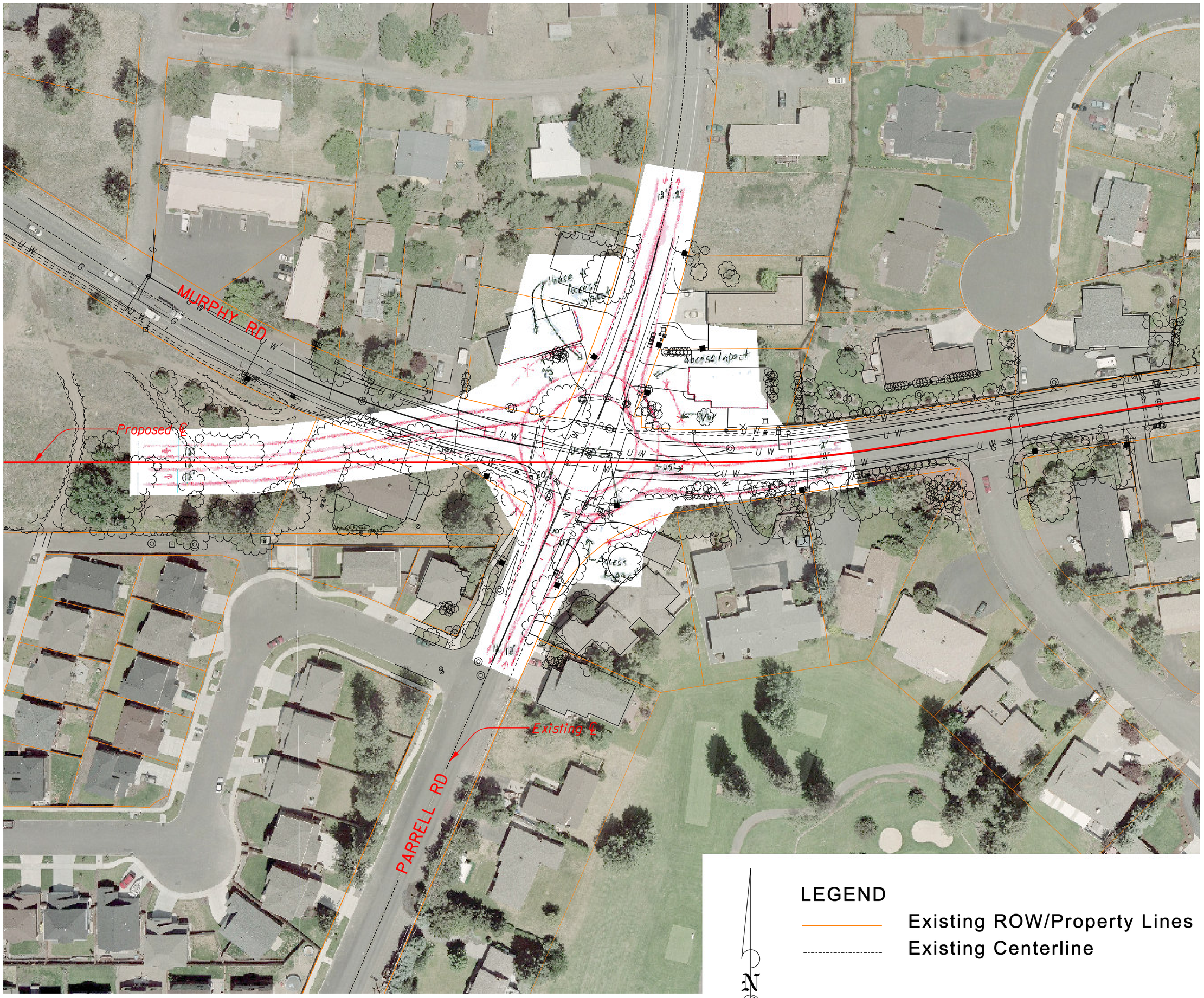

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CH2MHILL

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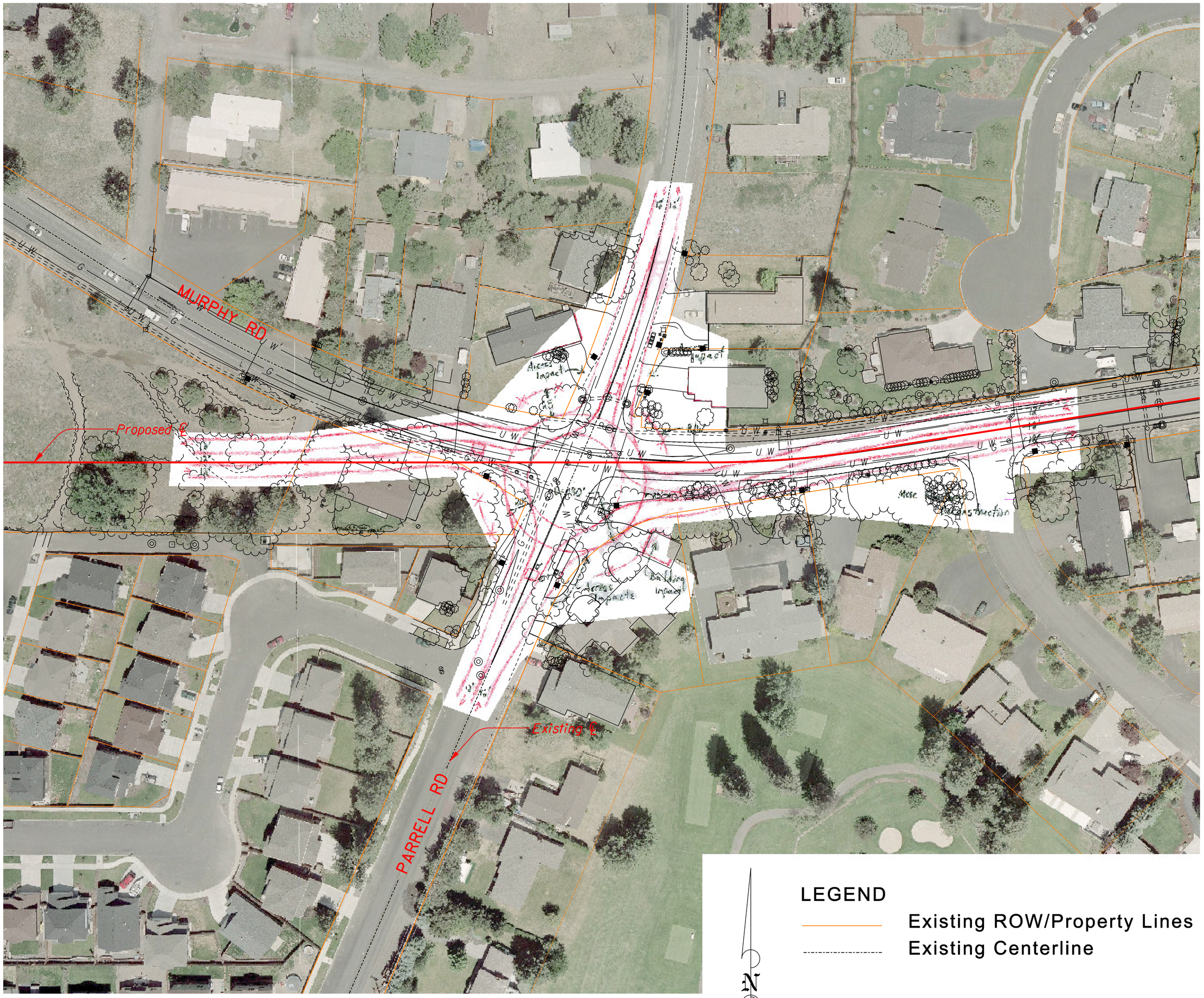

LEGEND

Existing ROW/Property Lines

Existing Centerline

PROJECT

MURPHY ROAD -
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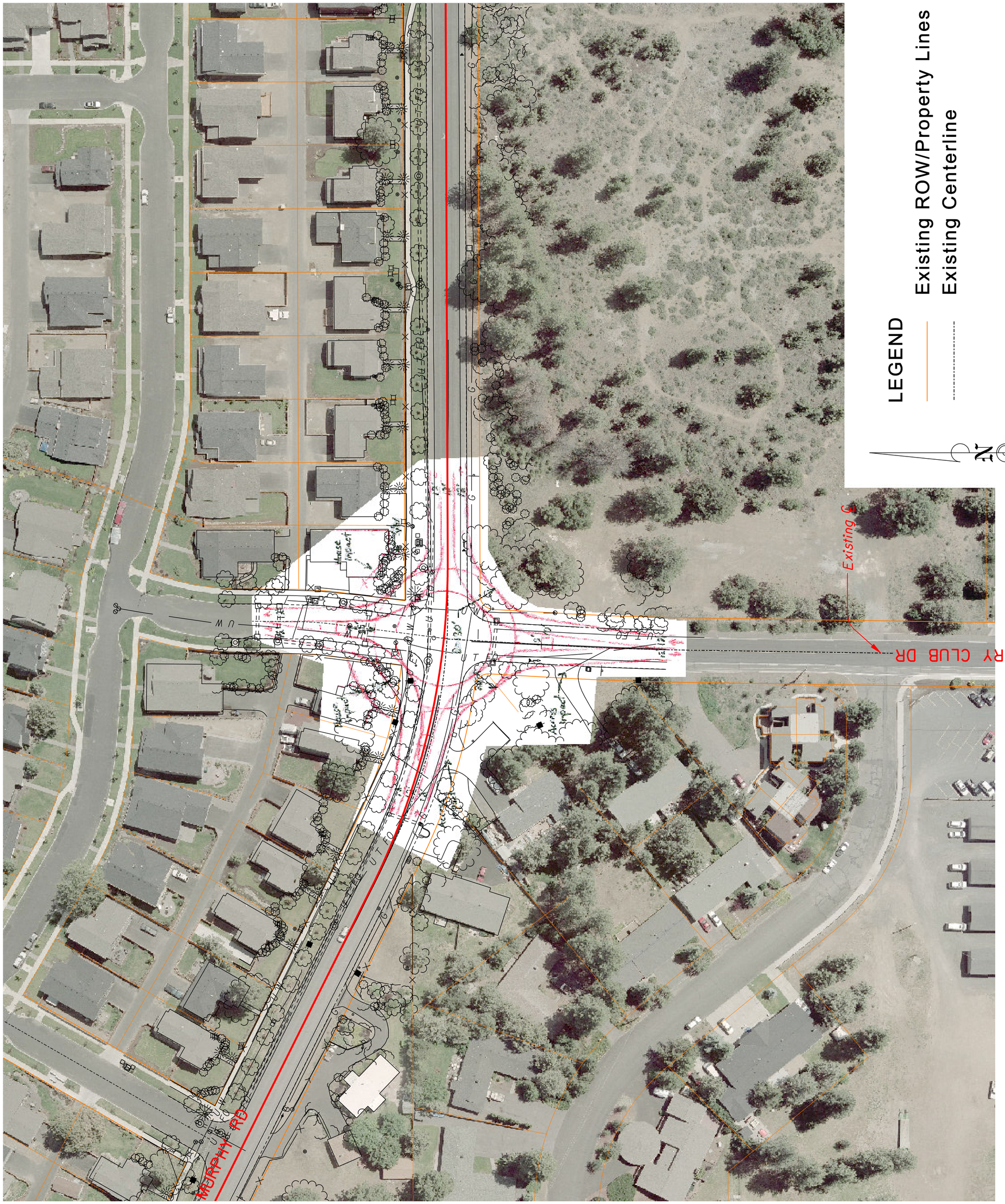
CH2MHILL



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MURPHY ROAD -

COUNTRY CLUB DR & MURPHY RD

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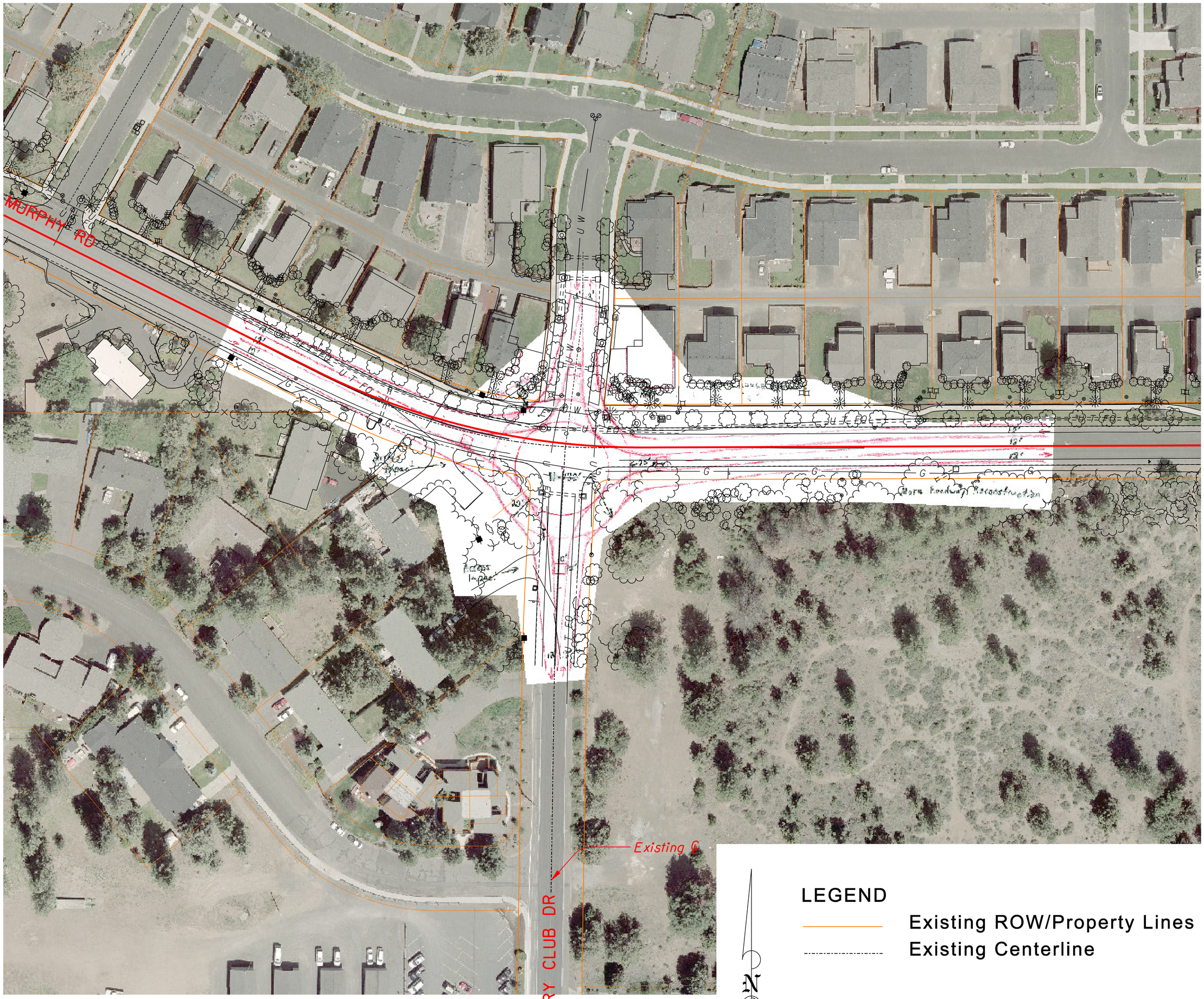

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CH2MHILL

MURPHY ROAD -

BROSTERHOUS RD & MURPHY RD

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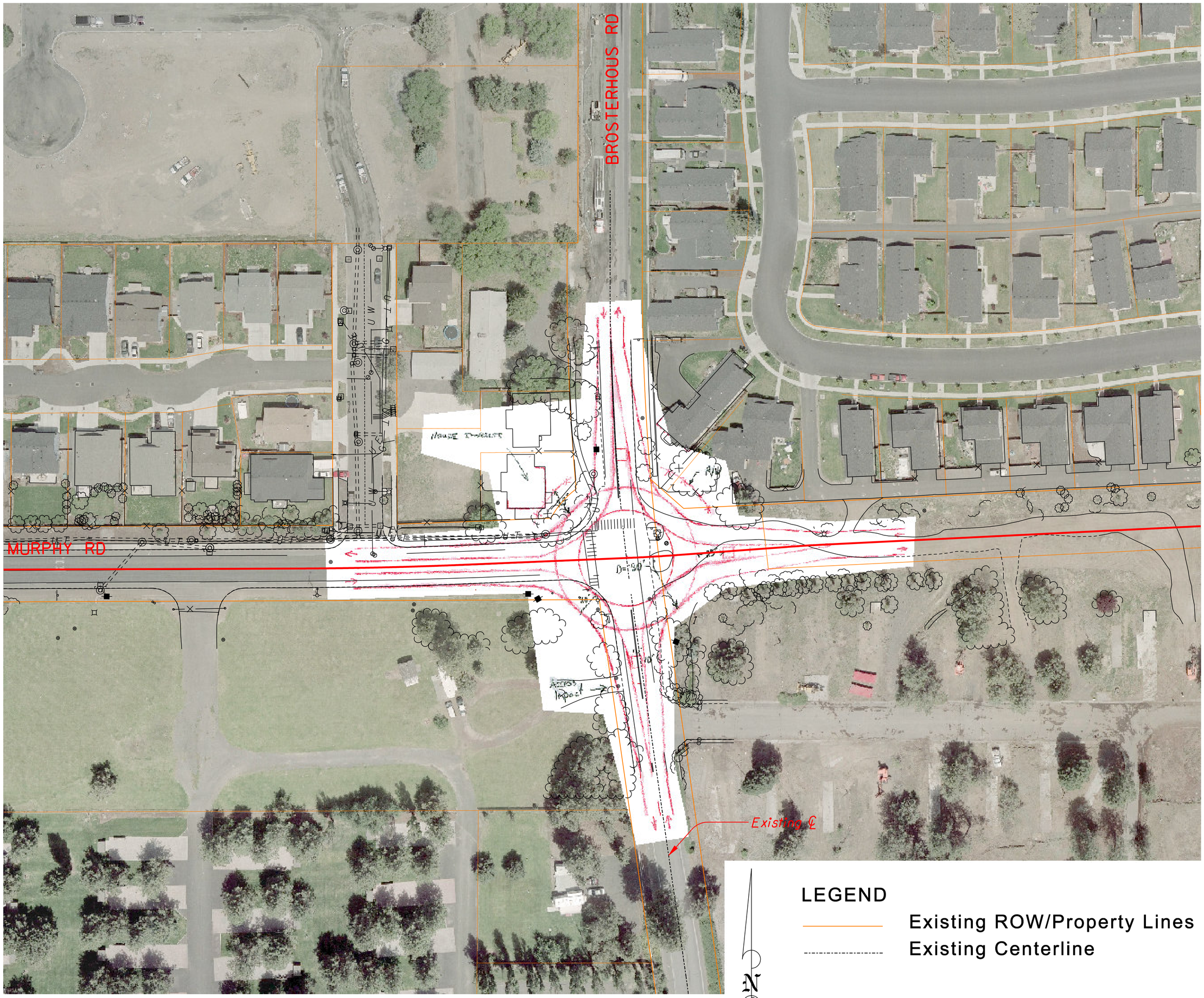

LEGEND

Existing ROW/Property Lines

Existing Centerline

N

0 50 100 150

Horizontal Scale In Feet

PROJECT

MURPHY ROAD -
BROSTERHOUS RD & MURPHY RD INTERSECTION

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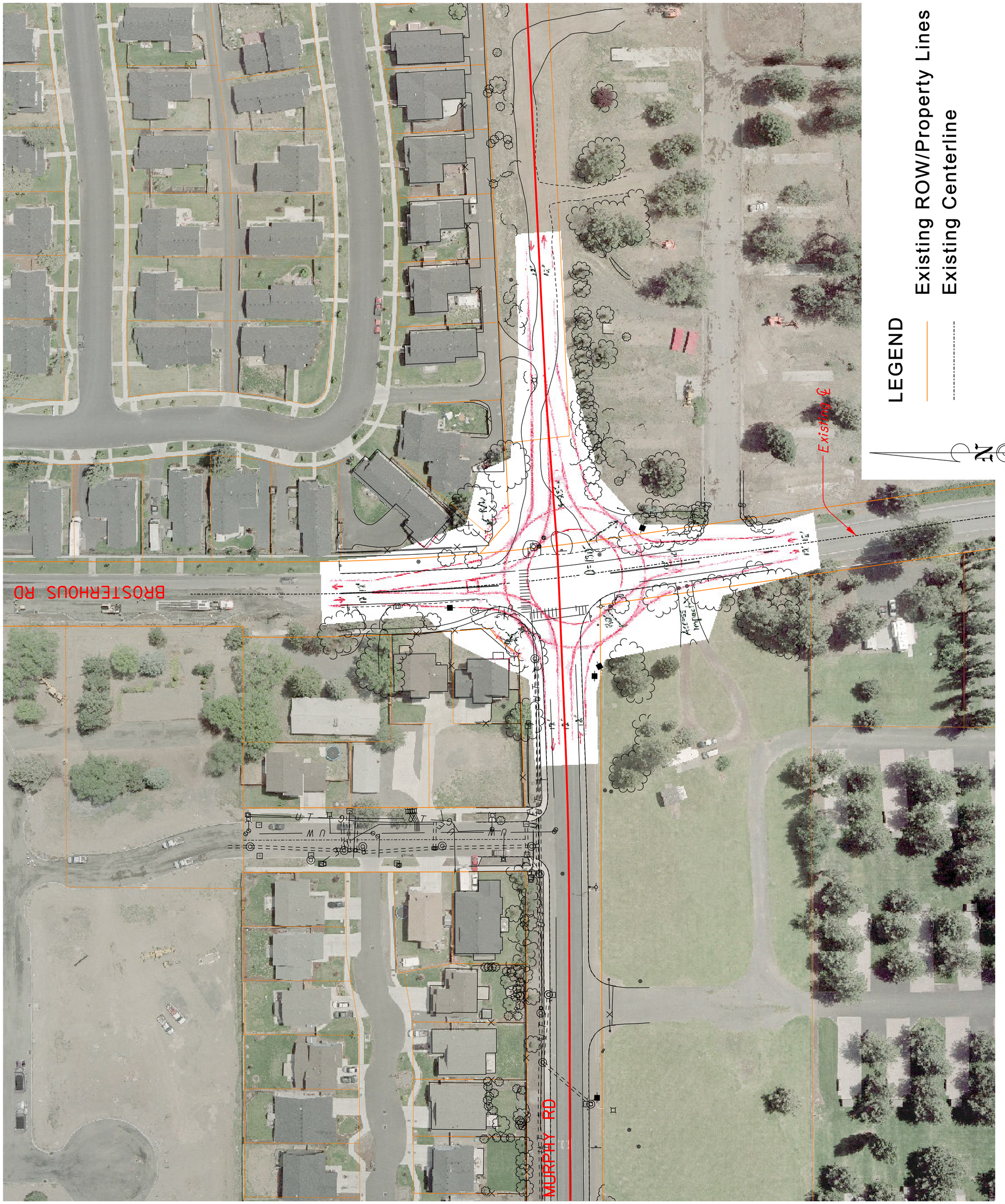

LEGEND

Existing ROW/Property Lines

Existing Centerline

N

0 50 100 150

Horizontal Scale In Feet

MURPHY ROAD - BROSTERHOUS RD & MURPHY RD

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PROJECT

MURPHY ROAD -

BROSTERHOUS RD & MURPHY RD INTERSECTION

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APPENDIX B

Drainage Technical Memorandum

Murphy Road Preliminary Drainage Design Memorandum

PREPARED FOR: City of Bend

PREPARED BY: Jeff Stallard,
Rick Attanasio, P.E.

DATE: April 28, 2009

PROJECT NUMBER: 348153.A2.07

Introduction

Upon completion of the Murphy Road Refinement Plan, the City of Bend (COB) requested CH2M HILL to advance with the preliminary design of Murphy Road from Brookswood Boulevard to 15th Street. The preliminary design for the stormwater system was to evaluate water quality and water quantity control options, and develop conceptual level plans based on these results. This memorandum summarizes the analysis performed.

To simplify discussion, the Murphy Road corridor was broken into three separate segments:

- Segment 1: Includes Murphy Road from Brookswood Boulevard to Parrell Road.
- Segment 2: Includes Murphy Road from Parrell Road to Brosterhous Road
- Segment 3: Includes Murphy Road from Brosterhous Road to 15th Street

Design Criteria

To establish the design criteria, the City of Bend Design Standards, the Central Oregon Stormwater manual and the Oregon Department of Transportation Hydraulic Manual were referenced. See Table 1 for a summary of the design standards utilized.

TABLE 1
Design Standards

Design Feature	Design Criteria	Reference
Road Classification	Major Collector	City of Bend
Spread Design	ODOT Standards per City Requirement 8' max (2' into traveled way) with 6' Target. This 6' target was based upon a 6' bike lane and the desire to keep the spread out of the traveled way.	ODOT Hydraulics Manual Appendix D
Drainage Inlets	25-yr design storm and 50-yr for design storm sag inlets	COSM Chapter 8
Storm Pipe Type	Concrete pipe 2' minimum cover from top of pipe to bottom of pavement. Bottom of pavement refers to the asphalt or concrete	COSM Chapter 8

	above the base.	
Conveyance	25 year flow	COSM Chapter 8
Culvert	50-yr design storm HW/D = 2 max	COSM Chapter 8
Water Quality	6-month 24-hr Type I storm which is calculated as 67% of the 2-yr 24-hr Type I Storm.	COSM Chapter 6
Water Quantity	$Q25_{pre} = Q25_{post}$ peak analysis	COSM Chapter 7
Inlet Type	Type CG-3 Inlet	ODOT
Drywells	Design Capacity (CF)= Vb+9.5*Vr+Vs=k*0.1A Vb= Barrell Volume, Vr=Rock Volume, k=1 A= Impervious Area 0.1' is rainfall depth required for sizing drywells	City of Bend Design Standard 2.A.13.B

Water Quality and Drywell Disposal Evaluation

The water quality evaluation approach was based on an October 9, 2008 meeting with City staff; Hardy Hanson, Ollie Fick and David Buchanan. The City expressed a strong preference for vegetative treatment as opposed to mechanical treatment (i.e. Storm Filters). Each segment was first evaluated for treatment options based on the available space within the City right-of-way to incorporate natural treatment. If natural treatment wouldn't fit within the proposed right-of-way, a mechanical form of treatment was sized. Water quality flows were generated utilizing the Santa Barbra Urban Hydrograph (SBUH) methodology with a 6-month 24-hr storm event. Drywell disposal capacity calculations follow the methodology in the COB Design Standard. See Appendix A for the water quality and drywell disposal calculations.

Segment 1

Station 38+00 Natural Water Quality Facility

The road profile for Segment 1 identified an approximate sag location at Station 38+00. The exact location for this water quality facility will be determined as the

Segment 1 design moves forward. The Segment 1 water quality facility is preliminarily sized to treat and dispose of runoff from 2.3-acres of roadway from the project. The system utilizes an infiltration swale and discharges flows above the water quality flow into drywells for disposal. The total water quality volume, based on SBUH methodology is 6,207 CF with a peak runoff of 0.39 CFS. This type of water quality facility allows for a reduction of the required volume to be disposed of through the use of drywells. The drywell disposal calculation were completed assuming a 20-foot drywell depth and identifies the requirement of 6 new drywells for disposal of all flows above the water quality flow.

Segment 2

Station 317+10 Mechanical Water Quality Facility at Mel Ct

The facility being proposed at Mel Ct. uses mechanical treatment (Storm Filters) to provide water quality treatment. A Storm Filter vault with multiple filter cartridges will discharge into new drywells. The mechanical facility is proposed at this location because there is no readily available land for construction of a vegetative natural treatment facility. This facility is preliminarily sized to treat and dispose of runoff from 1.4-acres of the roadway project, which generates a peak water quality flow of 0.24 CFS and a total water quality volume of 3,778 CF. This system is comprised of a 6-foot x 12-foot concrete vault housing 9 filter cartridges for treatment. Since space for open detention is not available at this location, the entire water quality volume is proposed to be disposed of utilizing 15 new drywells.

Station 340+62 Vegetative Water Quality Facility with Drywells

The location for the vegetative water quality facility (WQF) is the south side of Murphy Road at station 340+62. This is across from the Jewel School property. This facility is preliminarily sized to treat and dispose of runoff from 4-ac of roadway from the project. The system is comprised of an infiltration swale that discharges flows exceeding the water quality flow. The total water quality flow based on SBUH methodology is 10,794 Cubic Feet (CF) with a peak runoff of 0.75 Cubic Feet per Second (CFS). The vegetative WQF allows for a reduction of the required volume to be disposed of through the use of drywells. The drywell disposal calculation were completed assuming a 20-foot drywell depth and identifies the requirement of 4 new drywells for disposal of all flows above the water quality flow. The discharge depth of the storm system in relation to the adjacent land will result in a deep facility that will require extensive excavation for construction.

Segment 3

Station 376+99 Vegetative Water Quality Facility

The road profile for Segment 3 identifies one sag location at Station 376+99. The water quality facility location has been proposed for the north side of Murphy Road at this location. The Segment 3 water quality facility is preliminarily sized to treat and dispose of runoff from 1.4-acres of roadway from the project. The system utilizes an infiltration swale and then discharges flows exceeding the water quality flow into drywells for disposal. The total water quality volume, based on SBUH methodology, is 3,778 CF with a peak runoff of 0.26 CFS. The vegetative WQF allows for a reduction of the required volume to be disposed of through the use of drywells. The drywell disposal calculation was completed assuming a 20-foot dry well depth and identifies the requirement of 3 new drywells for disposal of all flows above the water quality flow.

Conveyance and Inlet Locations

The inlet spacing has been calculated, for an allowable spread of 6-feet, utilizing the 25-yr return event for all at grade inlets, and the 50-yr return event for all sag inlets. The allowable spread for safety considerations was limited to the 6-foot bike lane. This will allow the spread to remain within the proposed bike lane and out of any vehicular travel lanes. The conveyance system was design utilizing the Rational method, maintaining the hydraulic grade line within the pipe for a 25-yr return event. See Appendix B for all inlet spacing calculations completed, and Appendix C for all conveyance calculations.

Special design considerations

The bridge over the railroad in Segment 3 is superelevated with 2% shed section to the north. The road then transitions to a 2% superelevation to the south. Due to this transition from north to south an increased number of inlets were required to minimize the runoff crossing over Murphy Road from north to south. The amount of water transitioning across Murphy Road needs to be minimized as it would have the potential to create a safety hazard due to icing in the winter months.

Future Work Items

As this design effort described above preliminary, below are work items identified for the future design efforts on the Murphy Road Corridor.

1. The four corridor roundabouts located at Country Club Drive, Brookswood Boulevard, Brosterhous Road, and 15th Street at this time have not been graded in detail. Therefore, drainage design was not completed. For the cost estimate, it was assumed that each roundabout would require 12 inlets, 4 Manholes, and 200 lineal feet of 12-inch storm pipe.

2. The bridge over Bend Parkway was not completed as part of this study. Due to the winter weather conditions in Bend, the bridge drainage features should be analyzed closely to minimize the potential icy conditions typically associated with bridges.

APPENDIX A

Water Quality and Drywell Disposal Calculations

CH2MHILL

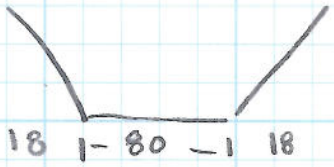
SUBJECT Murphy Road Seg 1 WQF @ STA 38+00 Drywell Disposal

BY JSS

SHEET NO. 1 of 4 DATE 4-27-09

PROJECT NO. 348153

Foot Print of WQF



Size = 80' wide x 100' Long

So 9" WQ Storage ≈ 8000 CF

Drywell Calculation

2.3 Acres Runoff Area = A = 100,188 ft²

20' Deep Drywells so h = 18

From Manual

$$\#wells\left[V_b + 9.5V_R + V_S\right] = 0.1A - WQ\ Storage$$

$V_b = \pi r^2 h = 3.14(2)^2(18) = 226$ CF

$V_R = 20$ CY From Manual type B standard

$V_S = 0$

This Gives us

$$\#\ wells\left[226 + 9.5(20) + (0)\right] = 0.1(100188) - 8000$$

$$\#wells = \frac{2018}{416} = 4.85 \rightarrow 5\ \text{Drywells For Disposal}$$

WQF will Be A 6' x 12' Storm Filter VAULT with 9 Filter CARTRIDGES So WQ STORAGE = 0

So Dry well Disposal

1.4 Acres of Runoff AREA = A = 60,984 ft^2

20' Deep wells So h = 18

From Bend MANUAL

$$\#\text{ wells}\left[V_b + 9.5\,V_R + V_S\right] = 0.1\,A - \text{WQ STORAGE}$$

$V_b = \pi R^2 h = 3.14(2)^2(18) = 226$ CF

V_R = 20 Cy From MANUAL type B STANDARD

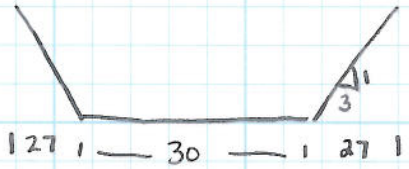
$V_S = 0$

This Gives us

$$\#\text{ wells}\left[226 + 9.5(20) + 0\right] = 0.1(60,984) - 0$$

#wells = 14.65 → 15 Dry wells For Disposal

Foot Print of WQF



Size 30' wide x 500' Long

So 9" WQ Depth Volume $\approx$ 15,000 ft^3 = WQ Storage

Drywell Calculation

4 Acres of Run off AREA = A = 174,240 ft^2

20' Deep wells, so h = 18

From Bend Manual

$$\#_{wells}\left[Vb + 9.5\,VR + Vs\right] = 0.1\,A - WQ\ Storage$$

$Vb = \pi r^2 h \rightarrow 3.14(2)^2(18) = 226$ CF

Vr = 20 CY From Manual Type B (Standard)

Vs = 0

This Gives us

$$\#_{wells}\left[226 + (9.5)(20) + 0\right] = 0.1\,(174{,}240) - 15{,}000$$

$$\#_{wells} = \frac{2424}{416} = 5.8 \rightarrow 6 \text{ Dry wells for Disposal}$$

Foot Print of WQF

Size = 70' wide x 75' Long

So 9" WQ Storage ≈ 5100 CF

Dry well Calculation

1.4 Acres Runoff Area = A = 60,984 ft²

20' Deep wells, so h = 18

From Bend Manual

$$\#\text{wells}\left[V_b + 9.5\,V_R + V_S\right] = 0.1\,A - \text{WQ Storage}$$

$V_b = \pi r^2 h = 3.14\,(2)^2(18) = 226$ CF

$V_r = 20$ CY From Manual type B standard

$V_S = 0$

This gives us

$$\#\text{wells}\left[226 + 9.5(20) + 0\right] = 0.1(60{,}984) - 5100$$

$$\#\text{wells} = \frac{998}{416} = 2.4 \rightarrow$$ 3 Dry wells for Disposal

SBUH DESIGN WORKSHEET

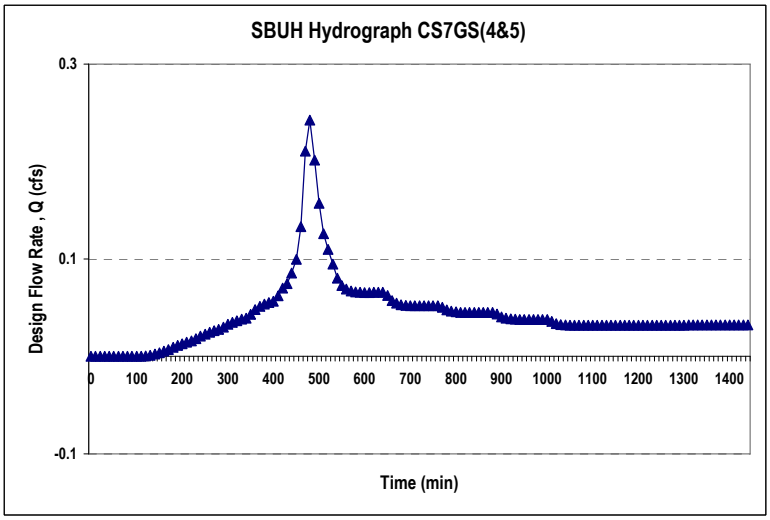
PROJECT:	Murphy Road	
BASIN	Bend, OR	
OUTFALL:		
LOCATION:	Sta 317+10	
TREATMENT FACILITY:	Mechanical	
FACILITY NAME:		
TOTAL IMPERVIOUS AREA	60,984	sq ft
	1.40	acre

Parameters		**Units**			**Comments**			
Total length of Flow	1740	ft						
Sheet Flow Segment								
Length	30	ft						
Slope of hydraulic Grid Line - S_o	0.02	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.25				*[City of Portland Stormwater Management Manual 2004 page 2-74]*			
Travel time (sheet Flow Segment) $T_1 = 0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	6.4	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	0	ft						
S_o	0.005	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	1.44	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	0.0	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	1710	ft			Assume sheet flows empty into inlets connected to pipes.			
T_3 = L/(60*V)	9.5	min			Assume pipe flow velocity of 3fps			
Given Area	1.4	acres						
P_t Depth of Rainfall	0.94	in			67% of 2 year at 1.4			
d_t	10	min						
T_c	15.9	min			From Conveyance Spreadsheet			
Routing Constant w= $d_t/(2T_c+d_t)$	0.240							
Pervious Area (acres)	0.0		CN	85	S = (1000/CN)-10	1.7647059	0.2*S	0.352941
Impervious Area (acres)	1.4		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816
Inputs								

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

Peak Design Flow Rate	0.24	cfs
Total Runoff	0.74	in
Total Runoff Volume	3,778	cf



SBUH DESIGN WORKSHEET

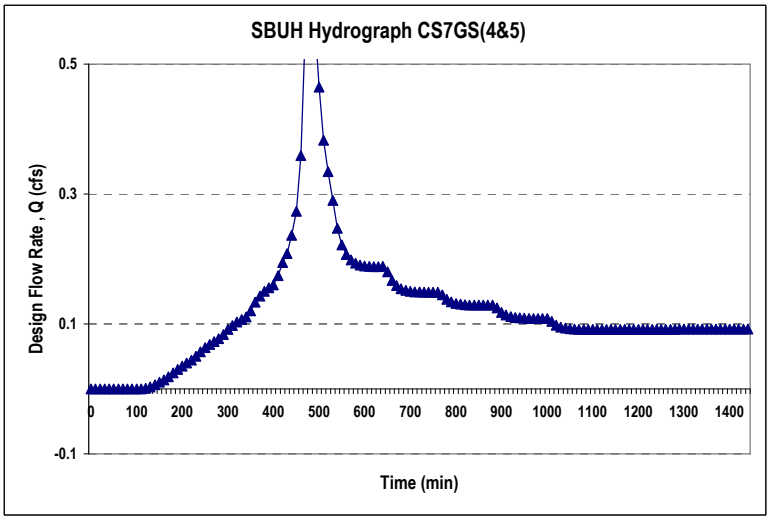
PROJECT:	Murphy Road	
BASIN	Bend, OR	
OUTFALL:		
LOCATION:	Sta 340+62	
TREATMENT FACILITY:	Grassy Swale	
FACILITY NAME:		
TOTAL IMPERVIOUS AREA	174,240	sq ft
	4.00	acre

Parameters		**Units**			**Comments**			
Total length of Flow	1658	ft						
Sheet Flow Segment								
Length	58	ft						
Slope of hydraulic Grid Line - S_o	0.02	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.25				*[City of Portland Stormwater Management Manual 2004 page 2-74]*			
Travel time (sheet Flow Segment) $T_1 = 0.42 (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	10.8	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	0	ft						
S_o	0.005	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	1.44	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	0.0	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	1600	ft			Assume sheet flows empty into inlets connected to pipes.			
T_3 = L/(60*V)	8.9	min			Assume pipe flow velocity of 3fps			
Given Area	4.0	acres						
P_t Depth of Rainfall	0.94	in			67% of 2 year which is 1.4			
d_t	10	min						
T_c	19.7	min			From Conveyance Spreadsheet			
Routing Constant w= $d_t/(2T_c+d_t)$	0.203							
Pervious Area (acres)	0.0		CN	85	S = (1000/CN)-10	1.7647059	0.2*S	0.352941
Impervious Area (acres)	4.0		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816
Inputs								

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

Peak Design Flow Rate	0.65	cfs
Total Runoff	0.74	in
Total Runoff Volume	10,794	cf



SBUH DESIGN WORKSHEET

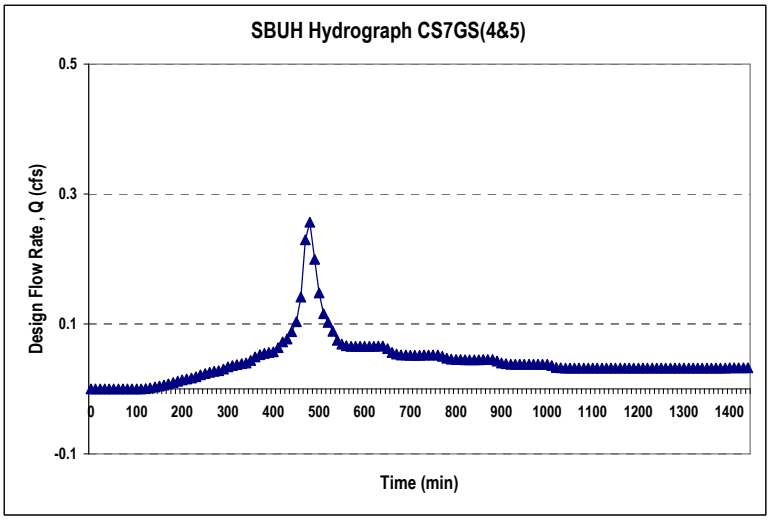
PROJECT:	Murphy Road	
BASIN	Bend, OR	
OUTFALL:		
LOCATION:	Sta 376+99	
TREATMENT FACILITY:	Grassy Swale	
FACILITY NAME:		
TOTAL IMPERVIOUS AREA	60,984	sq ft
	1.40	acre

Parameters		**Units**			**Comments**			
Total length of Flow	1130	ft						
Sheet Flow Segment								
Length	30	ft						
Slope of hydraulic Grid Line - S_o	0.02	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.25				*[City of Portland Stormwater Management Manual 2004 page 2-74]*			
Travel time (sheet Flow Segment) $T_1 = 0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	6.4	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	0	ft						
S_o	0.005	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	1.44	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	0.0	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	1100	ft			Assume sheet flows empty into inlets connected to pipes.			
T_3 = L/(60*V)	6.1	min			Assume pipe flow velocity of 3fps			
Given Area	1.4	acres						
P_t Depth of Rainfall	0.94	in			67% of 2 year at 1.4			
d_t	10	min						
T_c	12.5	min			From Conveyance Spreadsheet			
Routing Constant w= $d_t/(2T_c+d_t)$	0.286							
Pervious Area (acres)	0.0		CN	85	S = (1000/CN)-10	1.7647059	0.2*S	0.352941
Impervious Area (acres)	1.4		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816
Inputs								

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

Peak Design Flow Rate	0.26	cfs
Total Runoff	0.74	in
Total Runoff Volume	3,778	cf



SBUH DESIGN WORKSHEET

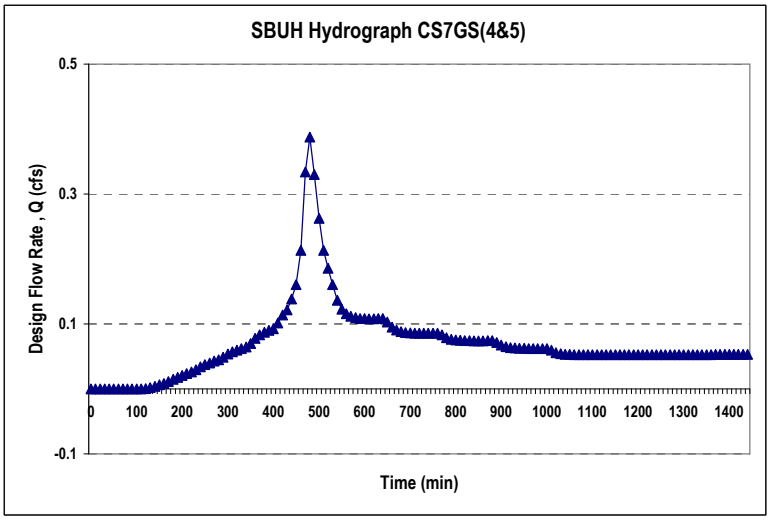
PROJECT:	Murphy Road	
BASIN	Bend, OR	
OUTFALL:		
LOCATION:	Sta 38+00	
TREATMENT FACILITY:	Grassy Swale	
FACILITY NAME:		
TOTAL IMPERVIOUS AREA	100,188	sq ft
	2.30	acre

Parameters		**Units**			**Comments**			
Total length of Flow	0	ft						
Sheet Flow Segment								
Length	30	ft						
Slope of hydraulic Grid Line - S_o	0.02	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.25				*[City of Portland Stormwater Management Manual 2004 page 2-74]*			
Travel time (sheet Flow Segment) $T_1 = 0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	6.4	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	0	ft						
S_o	0.005	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	1.44	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	0.0	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	2000	ft			Assume sheet flows empty into inlets connected to pipes.			
T_3 = L/(60*V)	11.1	min			Assume pipe flow velocity of 3fps			
Given Area	2.3	acres						
P_t Depth of Rainfall	0.94	in			67% of 2 year at 1.4			
d_t	10	min						
T_c	17.5	min			From Conveyance Spreadsheet			
Routing Constant w= $d_t/(2T_c+d_t)$	0.222							
Pervious Area (acres)	0.0		CN	85	S = (1000/CN)-10	1.7647059	0.2*S	0.352941
Impervious Area (acres)	2.3		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816
Inputs								

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

Peak Design Flow Rate	0.39	cfs
Total Runoff	0.74	in
Total Runoff Volume	6,207	cf



APPENDIX B
Inlet Design Calculations

Inlet Placement
Project: Murphy Road
Job Number: 348153

Side	Inlet Sta	From Sta	To Sta	Section Width (ft)	Section Length (ft)	Area (ac)	C 0.90	Time T_c (min)	Intensity I (in/hr)	Flow Q (cfs)	Pavement Long. S_L (ft/ft)	Pavement Cross S_x (ft/ft)	Equiv Cross S_e (ft/ft)	Pavement Manning's n 0.012	Prev. Bypass Q_{bp} (cfs)	Total Gutter Q_{tot} (cfs)	Flow Depth D (ft)	Spread T (ft)	Grate Width W (ft)	Opening Length L (ft)	Opening Required Lt (ft)	Gutter Velocity V_g (ft/sec)	Efficiency E	Intercepted Flow Q_i (cfs)	Bypass Flow Q_{bp} (cfs)	
Super Left Sta 36+550 to 370+60																										
L	**367+00**	36550	36700	48	150	0.165	0.9	5.0	2.7	0.402	0.034	0.04	0.110	0.012	0	0.402	0.095	2.39	2	2.5	7.893	1.80	0.50	0.20	0.20	
L	**367+50**	36700	36750	48	50	0.055	0.9	5.0	2.7	0.134	0.045	0.04	0.119	0.012	0.20	0.336	0.084	2.11	2	2.5	7.628	1.93	0.51	0.17	0.16	
L	**368+00**	36750	36800	48	50	0.055	0.9	5.0	2.7	0.134	0.056	0.04	0.126	0.012	0.16	0.298	0.077	1.94	2	2.5	7.493	2.06	0.52	0.15	0.14	
L	**368+50**	36800	36850	48	50	0.055	0.9	5.0	2.7	0.134	0.067	0.04	0.131	0.012	0.14	0.278	0.073	1.82	2	2.5	7.484	2.19	0.52	0.14	0.13	
L	**369+00**	36850	36900	48	50	0.055	0.9	5.0	2.7	0.134	0.079	0.04	0.135	0.012	0.13	0.267	0.070	1.75	2	2.5	7.578	2.30	0.51	0.14	0.13	
L	**369+40**	36900	36940	48	40	0.044	0.9	5.0	2.7	0.107	0.075	0.04	0.139	0.012	0.13	0.237	0.067	1.68	2	2.5	7.001	2.38	0.55	0.13	0.11	
L	**369+80**	36940	36980	48	40	0.044	0.9	5.0	2.7	0.107	0.070	0.04	0.141	0.012	0.11	0.214	0.066	1.64	2	2.5	6.487	2.43	0.58	0.13	0.09	
L	**370+20**	36980	37020	48	40	0.044	0.9	5.0	2.7	0.107	0.096	0.04	0.151	0.012	0.09	0.196	0.060	1.50	2	2.5	6.617	2.84	0.57	0.11	0.08	
L	**370+40**	37020	37040	48	20	0.022	0.9	5.0	2.7	0.054	0.061	0.04	0.157	0.012	0.08	0.137	0.057	1.42	2	2.5	4.858	2.94	0.73	0.10	0.04	
L	**370+50**	37040	37050	48	10	0.011	0.9	5.0	2.7	0.027	0.060	0.04	0.195	0.012	0.04	0.064	0.043	1.08	2	2.5	3.079	10.07	0.95	0.06	0.00	
Super Right Sta 370+60 to 377+34																										
R	**373+00**	37050	37300	48	250	0.275	0.9	5.0	2.7	0.669	0.045	0.02	0.059	0.012	0.00	0.669	0.084	4.22	2	2.5	15.426	1.42	0.27	0.18	0.49	
R	**375+50**	37300	37550	48	250	0.275	0.9	5.0	2.7	0.669	0.022	0.02	0.055	0.012	0.49	0.669	0.096	4.81	2	2.5	13.180	1.38	0.32	0.21	0.46	
R	**376+50**	37550	37650	48	100	0.110	0.9	5.0	2.7	0.268	0.008	0.02	0.060	0.012	0.46	0.268	0.084	4.18	2	2.5	6.139	1.29	0.61	0.16	0.10	
Sag at Sta 376+99 Right Side																										
R	**376+99**	37650	37801	Varies	151	0.129	0.9	5.0	3	0.348	0.000	0.02			0.15	0.453	0.067	3.34								Spread From Flow Master
R	**377+09**																									
Crown Section at Sta 377+34 to 378+01																										
L	377+34	37801	37734	48	67	0.074	0.9	5.0	2.7	0.179	0.005	0.02	0.063	0.012	0.00	0.179	0.077	3.86	2	2.5	4.484	1.21	0.77	0.14	0.04	
Sag at Sta 349+01																										
L	**362+50**	36550	36250	24	300	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.29	2	2.5	8.999	1.35	0.44	0.18	0.22	
L	**359+50**	36250	35950	24	300	0.165	0.9	5.0	2.7	0.402	0.039	0.02	0.059	0.012	0.22	0.625	0.085	4.23	2	2.5	14.365	1.41	0.29	0.18	0.44	
L	**356+50**	35950	35650	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.046	0.012	0.22	0.845	0.129	6.44	2	2.5	11.628	1.37	0.35	0.30	0.55	
L	**353+50**	35650	35350	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.045	0.012	0.44	0.948	0.135	6.73	2	2.5	12.383	1.38	0.33	0.32	0.63	
L	**350+50**	35350	35050	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.044	0.012	0.55	1.033	0.139	6.95	2	2.5	12.977	1.39	0.32	0.33	0.70	
L	**349+61**	35050	34961	24	89	0.049	0.9	5.0	2.7	0.119	0.005	0.02	0.044	0.012	0.63	0.822	0.138	6.88	2	2.5	10.405	1.36	0.39	0.32	0.50	
L	**349+30**	35050	34930	24	120	0.066	0.9	5.0	2.7	0.161	0.003	0.02	0.042	0.012	0.70	0.864	0.153	7.67	2	2.5	9.528	1.37	0.42	0.36	0.50	
L	**349+01**	34930	34700	24	230	0.127	0.9	5.0	2.7	0.308		0.02			0.63	0.902	0.144	7.19								Spread From Flow Master
L	**348+91**																									
L	**346+75**	34505	34700	24	195	0.107	0.9	5.0	2.7	0.261	0.006	0.02	0.059	0.012	0.00	0.261	0.086	4.29	2	2.5	5.800	1.27	0.64	0.17	0.09	
L	**345+05**	34452	34505	24	53	0.029	0.9	5.0	2.77	0.073	0.002	0.02	0.072	0.012	0.00	0.073	0.064	3.21	2	2.5	2.223	0.82	1.00	0.07	0.00	
Sag at Sta 340+62																										
L	**340+62**	34452	34062	24	626	0.345	0.9	5.0	3	0.931		0.02			0.27	1.197	0.144	7.20								Spread From Flow Master
L	**340+52**																									
L	**332+26**	32926	33226	24	300	0.165	0.9	5.0	2.7	0.402	0.016	0.02	0.060	0.012	0.00	0.402	0.084	4.21	2	2.5	9.184	1.36	0.44	0.17	0.23	
L	**335+26**	33226	33526	24	300	0.165	0.9	5.0	2.7	0.402	0.007	0.02	0.049	0.012	0.23	0.628	0.116	5.78	2	2.5	9.850	1.35	0.41	0.26	0.37	
L	**337+43**	33743	33774																							
L	**337+75**	33526	33811	24	285	0.157	0.9	5.0	2.7	0.382	0.006	0.02	0.046	0.012	0.37	0.753	0.129	6.43	2	2.5	10.354	1.36	0.39	0.29	0.46	
L	**338+11**	33775	33811	24	36	0.020	0.9	5.0	2.7	0.048	0.006	0.02	0.050	0.012	0.46	0.506	0.111	5.54	2	2.5	8.318	1.32	0.47	0.24	0.27	
Sag at Sta 325+72																										
L	**Roundabout to be designed in the future**			24	0	0.000	0.9	5.0	3	0.000		0.02			0.00	0.000	0.078	3.89								Spread From Flow Master
L																										
Sag at Sta 317+07																										
L	**320+56**	32226	32056	24	170	0.094	0.9	5.0	2.7	0.228	0.025	0.02	0.073	0.012	0	0.228	0.063	3.14	2	2.5	7.284	1.41	0.53	0.12	0.11	
L	**320+10**	32056	32010	24	46	0.025	0.9	5.0	2.7	0.062	0.025	0.02	0.107	0.012	0.11	0.062	0.038	1.92	2	2.5	3.353	1.52	0.91	0.06	0.01	
L	**317+30**	32010	31730	24	280	0.154	0.9	5.0	2.7	0.375	0.025	0.02	0.064	0.012	0.01	0.375	0.076	3.79	2	2.5	9.724	1.39	0.41	0.16	0.22	
L	**317+07**	31730	31707	24	23	0.013	0.9	5.0	3	0.034		0.02			0.63	0.550	0.079	3.97								Spread From Flow Master
L	**316+97**																									
L	**311+57**	30857	31157	24	300	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.30	2	2.5	8.958	1.35	0.45	0.18	0.22	
L	**314+57**	31157	31457	24	300	0.165	0.9	5.0	2.7	0.402	0.024	0.02	0.056	0.012	0.00	0.625	0.093	4.64	2	2.5	12.826	1.39	0.32	0.20	0.42	
L	**316+57**	31457	31657	24	200	0.110	0.9	5.0	2.7	0.268	0.006	0.02	0.047	0.012	0.00	0.691	0.124	6.21	2	2.5	9.915	1.35	0.41	0.28	0.41	
Sag at Sta 305+54																										
L	**305+54**	30857	30554	24	303	0.167	0.9	5.0	3	0.451		0.02			0.00	0.451	0.066	3.28								Spread From Flow Master
L	**305+44**																									
TO BE COMPLETED WITH SEGMENT 1																										

Sag at Sta 349+01																									
R	**362+50**	36550	36250	24	300	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.29	2	2.5	8.999	1.35	0.44	0.18	0.22	
R	**359+50**	36250	35950	24	300	0.165	0.9	5.0	2.7	0.402	0.039	0.02	0.059	0.012	0.22	0.625	0.085	4.23	2	2.5	14.365	1.41	0.29	0.18	0.44	
R	**356+50**	35950	35650	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.046	0.012	0.22	0.845	0.129	6.44	2	2.5	11.628	1.37	0.35	0.30	0.55	
R	**353+50**	35650	35350	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.045	0.012	0.44	0.948	0.135	6.73	2	2.5	12.383	1.38	0.33	0.32	0.63	
R	**350+50**	35350	35050	24	300	0.165	0.9	5.0	2.7	0.402	0.008	0.02	0.044	0.012	0.55	1.033	0.139	6.95	2	2.5	12.977	1.39	0.32	0.33	0.70	
R	**349+30**	35050	34930	24	120	0.066	0.9	5.0	2.7	0.161	0.003	0.02	0.042	0.012	0.70	0.864	0.153	7.67	2	2.5	9.528	1.37	0.42	0.36	0.50	
R	**349+11**																									
R	**349+01**	34930	34700	24	230	0.127	0.9	5.0	2.7	0.308		0.02			0.63	0.928	0.144	7.19								Spread From Flow Master
R	**346+75**	34475	34700	24	225	0.124	0.9	5.0	2.7	0.301	0.006	0.02	0.057	0.012	0.00	0.301	0.090	4.52	2	2.5	6.291	1.28	0.60	0.18	0.12	
R	**345+06**	34452	34475	24	23	0.013	0.9	5.0	2.77	0.032	0.002	0.02	0.091	0.012	0.00	0.032	0.047	2.34	2	2.5	1.359	0.59	1.00	0.03	0.00	
Sag at Sta 340+62																										
R	**340+62**	34452	34062	24	626	0.345	0.9	5.0	3	0.931		0.02			0.26	1.187	0.144	7.20								Spread From Flow Master
R	**340+52**																									
R	**332+26**	32926	33226	24	300	0.165	0.9	5.0	2.7	0.402	0.016	0.02	0.060	0.012	0.00	0.402	0.084	4.21	2	2.5	9.184	1.36	0.44	0.17	0.23	
R	**335+26**	33226	33526	24	300	0.165	0.9	5.0	2.7	0.402	0.007	0.02	0.049	0.012	0.23	0.628	0.116	5.78	2	2.5	9.850	1.35	0.41	0.26	0.37	
R	**337+56**	33526	33756	24	230	0.127	0.9	5.0	2.7	0.308	0.006	0.02	0.047	0.012	0.37	0.679	0.124	6.19	2	2.5	9.785	1.35	0.41	0.28	0.40	
R	**338+26**	33756	33826	24	70	0.039	0.9	5.0	2.7	0.094	0.006	0.02	0.050	0.012	0.40	0.493	0.110	5.49	2	2.5	8.199	1.32	0.48	0.24	0.26	
Sag at Sta 325+72																										
R	**Roundabout to be designed in the future**			24	0	0.000	0.9	5.0	3	0.000		0.02			0.00	0.000	0.078	3.89								Spread From Flow Master
R																										
Sag at Sta 317+07																										
R	**320+25**	32226	32025	24	201	0.111	0.9	5.0	2.7	0.269	0.025	0.02	0.070	0.012	0	0.269	0.067	3.34	2	2.5	8.030	1.40	0.49	0.13	0.14	
R	**317+07**	32025	31657	24	368	0.203	0.9	5.0	3	0.547		0.02			0.41	1.094	0.079	3.97								Spread From Flow Master
R	**316+97**																									
R	**311+57**	30857	31157	24	300	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.30	2	2.5	8.958	1.35	0.45	0.18	0.22	
R	**314+57**	31157	31457	24	300	0.165	0.9	5.0	2.7	0.402	0.024	0.02	0.056	0.012	0.00	0.625	0.093	4.64	2	2.5	12.826	1.39	0.32	0.20	0.42	
R	**316+57**	31457	31657	24	200	0.110	0.9	5.0	2.7	0.268	0.006	0.02	0.047	0.012	0.00	0.691	0.124	6.21	2	2.5	9.915	1.35	0.41	0.28	0.41	
Sag at Sta 305+54																										
R	**305+54**	30857	30554	24	303	0.167	0.9	5.0	3	0.451		0.02			0.00	0.451	0.066	3.28								Spread From Flow Master
R	**305+44**																									
TO BE COMPLETED WITH SEGMENT 1																										
Segment 1 Sta 10+00 to Sta 30+28																										
L	**14+00**	1000	1400	18	400	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.29	2	2.5	8.999	1.35	0.44	0.18	0.22	
L	**16+00**	1400	1600	36	200	0.165	0.9	5.0	2.7	0.402	0.039	0.04	0.101	0.012	0.22	0.625	0.110	2.74	2	2.5	10.458	1.75	0.39	0.24	0.38	
L	**17+00**	1600	1700	36	100	0.083	0.9	5.0	2.7	0.201	0.008	0.04	0.086	0.012	0.22	0.583	0.145	3.63	2	2.5	6.831	1.55	0.56	0.33	0.26	
L	**18+00**	1700	1800	36	100	0.083	0.9	5.0	2.7	0.201	0.008	0.04	0.090	0.012	0.38	0.458	0.133	3.32	2	2.5	5.988	1.54	0.62	0.28	0.17	
L	**20+50**	1800	2050	36	250	0.207	0.9	5.0	2.7	0.502	0.008	0.04	0.083	0.012	0.26	0.675	0.153	3.84	2	2.5	7.391	1.56	0.52	0.35	0.32	
L	**23+50**	2050	2350	18	300	0.124	0.9	5.0	2.7	0.301	0.039	0.02	0.059	0.012	0.32	0.622	0.084	4.22	2	2.5	14.326	1.41	0.29	0.18	0.44	
L	**25+00**	2350	2500	18	150	0.062	0.9	5.0	2.7	0.151	0.008	0.02	0.050	0.012	0.32	0.591	0.113	5.64	2	2.5	9.553	1.34	0.42	0.25	0.34	
L	**26+50**	2500	2650	18	150	0.062	0.9	5.0	2.7	0.151	0.008	0.02	0.052	0.012	0.44	0.493	0.105	5.26	2	2.5	8.636	1.33	0.46	0.23	0.27	
L	**28+00**	2650	2800	18	150	0.062	0.9	5.0	2.7	0.151	0.039	0.02	0.066	0.012	0.27	0.417	0.073	3.63	2	2.5	11.392	1.42	0.36	0.15	0.27	
L	**30+28**	2800	3025	18	225	0.093	0.9	5.0	2.7	0.226	0.008	0.02	0.052	0.012	0.27	0.493	0.105	5.26	2	2.5	8.635	1.33	0.46	0.23	0.27	
Segment 1 Sta 10+00 to Sta 30+28																										
R	**14+00**	1000	1400	18	400	0.165	0.9	5.0	2.7	0.402	0.015	0.02	0.059	0.012	0.00	0.402	0.086	4.29	2	2.5	8.999	1.35	0.44	0.18	0.22	
R	**23+50**	2050	2350	18	300	0.124	0.9	5.0	2.7	0.301	0.039	0.02	0.064	0.012	0.00	0.475	0.076	3.82	2	2.5	12.280	1.42	0.34	0.16	0.32	
R	**25+00**	2350	2500	18	150	0.062	0.9	5.0	2.7	0.151	0.008	0.02	0.052	0.012	0.32	0.466	0.103	5.15	2	2.5	8.369	1.32	0.47	0.22	0.25	
R	**26+50**	2500	2650	18	150	0.062	0.9	5.0	2.7	0.151	0.008	0.02	0.054	0.012	0.25	0.397	0.097	4.85	2	2.5	7.646	1.31	0.51	0.20	0.19	
R	**28+00**	2650	2800	18	150	0.062	0.9	5.0	2.7	0.151	0.039	0.02	0.069	0.012	0.19	0.345	0.068	3.38	2	2.5	10.209	1.44	0.40	0.14	0.21	
R	**30+28**	2800	3025	18	225	0.093	0.9	5.0	2.7	0.226	0.008	0.02	0.053	0.012	0.21	0.434	0.100	5.02	2	2.5	8.042	1.32	0.49	0.21	0.22	

APPENDIX C
Conveyance Design Calculations

Conveyance Calculations
Project: **Murphy Rd.**
Job Number: **348153**

Location					Hydrology												Sewer Design						ewer Profi		
Description	Pipe From	Pipe To	Length (ft)	Width (ft)	Area (ft²)	Total Area (acres)	Cf = C	1.0 CfCA	Sum CA	Tc from STA (min)	Tc in Pipe (min)	Sum Tc (min)	Intensity I (in/hr)	Flow (cfs)	Offsite Flow (cfs)	Total Flow (cfs)	Diameter D (in)	Slope S (ft/ft)	Manning's n 0.013	Capacity Qf (cfs)	Velocity V (fps)	Q/Qf	Length L (ft)	Q/Qf Check	Slope Check
Murphy Road																									
Main line																									
SAG AT STA 376+99																									
From East	**378+01.00**	**377+34.00**	67.00	48.00	3216	0.07	0.90	0.07	0.07	**5.00**	0.37	**5.4**	2.70	0.18		**0.18**	**12**	0.45%	0.013	2.38	3.04	**0.08**	67.00	ok	ok
	377+34.00	**376+99.00**	35.00	48.00	1680	0.04	0.90	0.03	0.10	**5.37**	0.17	**5.5**	2.70	0.27		**0.27**	**12**	0.57%	0.013	2.69	3.43	**0.10**	35.00	ok	ok
From West	**365+50.00**	**367+00.00**	150.00	48.00	7200	0.17	0.90	0.15	0.15	**5.00**	0.50	**5.5**	2.70	0.40		**0.40**	**12**	1.23%	0.013	3.96	5.04	**0.10**	150.00	ok	ok
	367+00.00	**367+50.00**	50.00	48.00	2400	0.06	0.90	0.05	0.20	**5.50**	0.08	**5.6**	2.70	0.54		**0.54**	**12**	4.80%	0.013	7.80	9.94	**0.07**	50.00	ok	ok
	367+50.00	**368+00.00**	50.00	48.00	2400	0.06	0.90	0.05	0.25	**5.58**	0.13	**5.7**	2.70	0.67		**0.67**	**12**	2.00%	0.013	5.04	6.42	**0.13**	50.00	ok	ok
	368+00.00	**368+50.00**	50.00	48.00	2400	0.06	0.90	0.05	0.30	**5.71**	0.08	**5.8**	2.70	0.80		**0.80**	**12**	4.80%	0.013	7.80	9.94	**0.10**	50.00	ok	ok
	368+50.00	**369+00.00**	50.00	48.00	2400	0.06	0.90	0.05	0.35	**5.79**	0.08	**5.9**	2.70	0.94		**0.94**	**12**	4.84%	0.013	7.84	9.98	**0.12**	50.00	ok	ok
	369+00.00	**369+40.00**	40.00	48.00	1920	0.04	0.90	0.04	0.39	**5.88**	0.07	**5.9**	2.70	1.04		**1.04**	**12**	4.82%	0.013	7.82	9.97	**0.13**	40.00	ok	ok
	369+40.00	**369+80.00**	40.00	48.00	1920	0.04	0.90	0.04	0.29	**5.71**	0.04	**5.8**	2.70	0.78		**0.78**	**12**	11.38%	0.013	12.01	15.31	**0.06**	40.00	ok	ok
	369+80.00	**370+20.00**	40.00	48.00	1920	0.04	0.90	0.04	0.34	**5.79**	0.05	**5.8**	2.70	0.91		**0.91**	**12**	8.62%	0.013	10.46	13.33	**0.09**	40.00	ok	ok
	370+20.00	**370+40.00**	20.00	48.00	960	0.02	0.90	0.02	0.37	**5.88**	0.05	**5.9**	2.70	0.99		**0.99**	**12**	2.50%	0.013	5.63	7.18	**0.18**	20.00	ok	ok
	370+40.00	**370+50.00**	10.00	48.00	480	0.01	0.90	0.01	0.40	**5.94**	0.02	**6.0**	2.70	1.07		**1.07**	**12**	3.80%	0.013	6.94	8.85	**0.15**	10.00	ok	ok
	370+50.00	**373+00.00**	250.00	48.00	12000	0.28	0.90	0.25	0.54	**5.75**	0.43	**6.2**	2.70	1.45		**1.45**	**12**	4.59%	0.013	7.63	9.72	**0.19**	250.00	ok	ok
	373+00.00	**375+50.00**	250.00	48.00	12000	0.28	0.90	0.25	0.59	**5.84**	0.45	**6.3**	2.70	1.58		**1.58**	**12**	4.13%	0.013	7.24	9.23	**0.22**	250.00	ok	ok
	375+50.00	**376+50.00**	100.00	48.00	4800	0.11	0.90	0.10	0.47	**5.92**	0.34	**6.3**	2.70	1.26		**1.26**	**12**	1.17%	0.013	3.85	4.91	**0.33**	100.00	ok	ok
	376+50.00	**376+99.00**	49.00	48.00	2352	0.05	0.90	0.05	0.45	**5.96**	0.23	**6.2**	2.70	1.20		**1.20**	**12**	0.61%	0.013	2.79	3.55	**0.43**	49.00	ok	ok
SAG AT STA 340+62																									
From East																									
	362+50.00	**359+50.00**	300.00	48.00	14400	0.33	0.90	0.30	0.30	**5.00**	0.55	**5.5**	2.70	0.80		**0.80**	**12**	4.03%	0.013	7.15	9.11	**0.11**	300.00	ok	ok
	359+50.00	**356+50.00**	300.00	48.00	14400	0.33	0.90	0.30	0.60	**5.55**	0.80	**6.3**	2.70	1.61		**1.61**	**12**	1.90%	0.013	4.91	6.26	**0.33**	300.00	ok	ok
	356+50.00	**353+50.00**	300.00	48.00	14400	0.33	0.90	0.30	0.89	**6.35**	1.27	**7.6**	2.70	2.41		**2.41**	**12**	0.75%	0.013	3.08	3.93	**0.78**	300.00	ok	ok
	353+50.00	**350+50.00**	300.00	48.00	14400	0.33	0.90	0.30	1.19	**7.62**	1.19	**8.8**	2.70	3.21		**3.21**	**12**	0.85%	0.013	3.28	4.18	**0.98**	300.00	ok	ok
	350+50.00	**349+61.00**	89.00	48.00	4272	0.10	0.90	0.09	1.28	**8.81**	0.31	**9.1**	2.70	3.45		**3.45**	**12**	1.12%	0.013	3.78	4.81	**0.91**	89.00	ok	ok
	349+61.00	**349+30.00**	31.00	48.00	1488	0.03	0.90	0.03	1.31	**9.12**	0.11	**9.2**	2.70	3.53		**3.53**	**12**	1.13%	0.013	3.78	4.82	**0.93**	31.00	ok	ok
	349+30.00	**349+01.00**	29.00	48.00	1392	0.03	0.90	0.03	1.34	**9.23**	0.13	**9.4**	2.70	3.61		**3.61**	**15**	0.52%	0.013	4.64	3.79	**0.78**	29.00	ok	ok
	349+01.00	**348+91.00**	10.00	48.00	480	0.01	0.90	0.01	1.35	**9.36**	0.04	**9.4**	2.70	3.64		**3.64**	**15**	0.50%	0.013	4.57	3.72	**0.80**	10.00	ok	ok
	348+91.00	**347+00.00**	191.00	48.00	9168	0.21	1.90	0.40	1.75	**9.40**	0.80	**10.2**	2.70	4.72		**4.72**	**18**	0.45%	0.013	7.00	3.97	**0.67**	191.00	ok	ok
	347+00.00	**345+05.00**	195.00	48.00	9360	0.21	2.90	0.62	2.37	**10.21**	0.76	**11.0**	2.70	6.40		**6.40**	**18**	0.51%	0.013	7.52	4.26	**0.85**	195.00	ok	ok
	345+05.00	**344+52.00**	53.00	48.00	2544	0.06	3.90	0.23	2.60	**10.97**	0.20	**11.2**	2.70	7.02		**7.02**	**18**	0.57%	0.013	7.90	4.47	**0.89**	53.00	ok	ok
	344+52.00	**340+62.00**	390.00	48.00	18720	0.43	4.90	2.11	4.70	**11.17**	1.15	**12.3**	2.70	12.70		**12.70**	**24**	0.62%	0.013	17.74	5.65	**0.72**	390.00	ok	ok
From West																									
	325+72.00	**329+26.00**	354.00	48.00	16992	0.39	0.90	0.35	0.35	**5.00**	1.96	**7.0**	2.70	0.95		**0.95**	**12**	0.44%	0.013	2.36	3.01	**0.40**	354.00	ok	ok
	329+26.00	**332+26.00**	300.00	48.00	14400	0.33	0.90	0.30	0.65	**6.96**	1.59	**8.5**	2.70	1.75		**1.75**	**12**	0.48%	0.013	2.47	3.14	**0.71**	300.00	ok	ok
	332+26.00	**335+26.00**	300.00	48.00	14400	0.33	0.90	0.30	0.95	**8.55**	1.05	**9.6**	2.70	2.55		**2.55**	**12**	1.10%	0.013	3.73	4.75	**0.68**	300.00	ok	ok
	335+26.00	**337+43.00**	217.00	48.00	10416	0.24	0.90	0.22	1.16	**9.60**	0.79	**10.4**	2.70	3.14		**3.14**	**12**	1.01%	0.013	3.59	4.57	**0.87**	217.00	ok	ok
	337+43.00	**337+75.00**	32.00	48.00	1536	0.04	0.90	0.03	1.19	**10.39**	0.13	**10.5**	2.70	3.22		**3.22**	**15**	0.66%	0.013	5.23	4.27	**0.62**	32.00	ok	ok
	337+75.00	**338+11.00**	36.00	48.00	1728	0.04	0.90	0.04	1.23	**10.52**	0.12	**10.6**	2.70	3.32		**3.32**	**15**	0.83%	0.013	5.89	4.81	**0.56**	36.00	ok	ok
	338+11.00	**340+62.00**	251.00	48.00	12048	0.28	0.90	0.25	1.48	**10.64**	0.73	**11.4**	2.70	3.99		**3.99**	**15**	1.20%	0.013	7.06	5.76	**0.57**	251.00	ok	ok
SAG AT STA 317+07																									
From East																									
	320+56.00	**320+10.00**	46.00	48.00	2208	0.05	0.90	0.05	0.05	**5.00**	0.24	**5.2**	2.70	0.12		**0.12**	**12**	0.50%	0.013	2.52	3.21	**0.05**	46.00	ok	ok
	320+10.00	**317+30.00**	280.00	48.00	13440	0.31	0.90	0.28	0.32	**5.24**	0.79	**6.0**	2.70	0.87		**0.87**	**12**	1.71%	0.013	4.66	5.94	**0.19**	280.00	ok	ok
	317+30.00	**317+07.00**	23.00	48.00	1104	0.03	0.90	0.02	0.35	**6.02**	0.04	**6.1**	2.70	0.93		**0.93**	**12**	4.35%	0.013	7.43	9.46	**0.13**	23.00	ok	ok
From West	**308+57.00**	**311+57.00**	300.00	48.00	14400	0.33	0.90	0.30	0.30	**5.00**															
	311+57.00	**314+57.00**	300.00	48.00	14400	0.33	0.90	0.30	0.60	**5.00**	0.78	**5.8**	2.70	1.61		**1.61**	**12**	2.00%	0.013	5.04	6.42	**0.32**	300.00	ok	ok
	314+57.00	**316+57.00**	200.00	48.00	9600	0.22	0.90	0.20	0.79	**5.78**	0.60	**6.4**	2.70	2.14		**2.14**	**12**	1.50%	0.013	4.36	5.56	**0.49**	200.00	ok	ok
	316+57.00	**316+97.00**	40.00	48.00	1920	0.04	0.90	0.04	0.83	**6.38**	0.17	**6.6**	2.70	2.25		**2.25**	**12**	0.72%	0.013	3.03	3.86	**0.74**	40.00	ok	ok
	316+97.00	**317+07.00**	10.00	48.00	480	0.01	0.90	0.01	0.84	**6.55**	0.01	**6.6**	2.70	2.28		**2.28**	**12**	7.10%	0.013	9.49	12.09	**0.24**	10.00	ok	ok
SAG AT STA 38+00																									
From West																									
	14+00.00	**16+00.00**	200.00	36.00	7200	0.17	0.90	0.15	0.15	**5.00**	0.73	**5.7**	2.70	0.40		**0.40**	**12**	1.00%	0.013	3.56	4.54	**0.11**	200.00	ok	ok
	16+00.00	**17+00.00**	100.00	36.00	3600	0.08	0.90	0.07	0.22	**5.73**	0.52	**6.3**	2.70	0.60		**0.60**	**12**	0.50%	0.013	2.52	3.21	**0.24**	100.00	ok	ok
	17+00.00	**18+00.00**	100.00	36.00	3600	0.08	0.90	0.07	0.30	**6.25**	0.52	**6.8**	2.70	0.80		**0.80**	**12**	0.50%	0.013	2.52	3.21	**0.32**	100.00	ok	ok
	18+00.00	**20+50.00**	250.00	36.00	9000	0.21	0.90	0.19	0.48	**6.77**	1.30	**8.1**	2.70	1.31		**1.31**	**12**	0.50%	0.013	2.52	3.21	**0.52**	250.00	ok	ok
	20+50.00	**23+50.00**	300.00	36.00	10800	0.25	0.90	0.22	0.71	**8.07**	0.88	**8.9**	2.70	1.91		**1.91**	**12**	1.58%	0.013	4.48	5.71	**0.43**	300.00	ok	ok
	23+50.00	**25+00.00**	150.00	36.00	5400	0.12	0.90	0.11	0.82	**8.95**	0.45	**9.4**	2.70	2.21		**2.21**	**12**	1.50%	0.013	4.36	5.56	**0.51**	150.00	ok	ok
	25+00.00	**26+50.00**	150.00	36.00	5400	0.12	0.90	0.11	0.93	**9.40**	0.45	**9.8**	2.70	2.51		**2.51**	**12**	1.50%	0.013	4.36	5.56	**0.58**	150.00	ok	ok
	26+50.00	**28+00.00**	150.00	36.00	5400	0.12	0.90	0.11	1.04	**9.85**	0.63	**10.5**	2.70	2.81		**2.81**	**12**	0.77%	0.013	3.12	3.97	**0.90**	150.00	ok	ok
	28+00.00	**30+25.00**	225.00	36.00	8100	0.19	1.90	0.35	1.39	**10.48**	0.79	**11.3**	2.70	3.77		**3.77**	**15**	0.82%	0.013	5.86	4.78	**0.64**	225.00	ok	ok
	30+25.00	**33+25.00**	300.00	36.00	10800	0.25	2.90	0.72	2.11	**11.26**	1.19	**12.4**	2.70	5.71		**5.71**	**18**	0.50%	0.013	7.43	4.21	**0.77**	300.00	ok	ok
	33+25.00	**36+25.00**	300.00	36.00	10800	0.25	3.90	0.97	3.08	**12.45**	0.93	**13.4**	2.70	8.32		**8.32**	**21**	0.67%	0.013	12.93	5.38	**0.64**	300.00	ok	ok
	36+25.00	**38+00.00**	175.00	36.00	6300	0.14	3.90	0.56	3.64	**13.38**	0.59	**14.0**	2.70	9.84		**9.84**	**21**	0.57%	0.013	11.97	4.98	**0.82**	175.00	ok	ok

APPENDIX C

Cost Estimates

CITY OF BEND

PROJECT NAME MURPHY ROAD PRELIMINARY DESIGN

COST ESTIMATE SEGMENT 2

MARK-UPS	Percent	
ELEC/I&C	NOTE 1	
MECHANICAL	NOTE 2	
ALLOWANCE	10%	
MOB/BOND/INS	8%	
CONTINGENCY	NOTE 3	
ENGINEERING	NOTE 4	
CAPITALIZED INTEREST (BOND)	NOTE 5	COB PROVIDED
COB INTERNAL CHARGES	13%	COB PROVIDED
OTHER COB COSTS	NOTE 5	COB PROVIDED
ADMIN/LEGAL	5%	COB PROVIDED

Prepared By: BILLY ADAMS
Proj. Manager: DAVE SIMMONS
Project No: 348153
Date: October 7, 2009

NO.	DESCRIPTION	QTY	UNIT	Material Unit $	Installation Unit $	TOTAL	RESOURCE
A	CONSTRUCTION COST ESTIMATE						
1	MOBILIZATION	ALL	LS		10%	$346,200	
2	TEMPORARY PROTECTION AND DIRECTION OF TRAFFIC	ALL	LS		3.0%	$99,900	
3	EROSION CONTROL	ALL	LS		1.0%	$33,300	
4	REMOVALOF STRUCTURES AND OBSTRUCTIONS	ALL	LS		$51,000	$51,000	
5	CLEARING AND GRUBBING	ALL	LS		$55,250	$55,250	
6	GENERAL EXCAVATION	4770	CY		$15.00	$71,600	
7	SUBGRADE GEOTEXTILE	7780	SY		$1.50	$11,700	
8	12 INCH STORM SEWER PIPE, 5 FT DEPTH	4255	LF		$60	$255,300	
9	15 INCH STORM SEWER PIPE, 10 FT DEPTH	360	LF		$100	$36,000	
10	18 INCH STORM SEWER PIPE, 10 FT DEPTH	200	LF		$120	$24,000	
11	21 INCH STORM SEWER PIPE, 10 FT DEPTH	195	LF		$160	$31,200	
12	24 INCH STORM SEWER PIPE, 10 FT DEPTH	60	LF		$180	$10,800	
13	30 INCH STORM SEWER PIPE, 10 FT DEPTH	400	LF		$220	$88,000	
14	CONCRETE STORM SEWER MANHOLES	28	EA		$3,000	$84,000	
15	CONCRETE INLETS, TYPE CG-3	48	EA		$1,700	$81,600	
16	WATER QUALITY FACILITY	ALL	LS		$806,000	$806,000	
17	DRYWELL DISPOSAL	ALL	LS		$189,000	$189,000	
18	COLD PLANE PAVEMENT REMOVAL, 0 - 2 INCHES DEEP	25370	SY		$5.00	$126,900	
19	AGGREGATE BASE (Note 6)	5,972	TON		$22.00	$131,400	
20	CONCRETE CURBS, CURB AND GUTTER	9,493	LF		$15.00	$142,400	
21	CONCRETE CURBS, STANDARD CURB	3030	LF		$12.00	$36,400	
22	CONCRETE WALKS (INCL DW APRONS)	61673	SF		$4.00	$246,700	
23	LEVEL 3, HMAC (Note 6)	ALL	LS		$442,960	$442,960	
24	SIGNING AND STRIPING	ALL	LS		$61,930	$61,930	
25	LANDSCAPING	ALL	LS		$71,160	$71,160	
26	ILLUMINATION, COMPLETE	ALL	LS		$175,000	$175,000	
27	RETAINING WALL	ALL	LS		$98,100	$98,100	
28	COUNTRY CLUB ROUNDABOUT	ALL	LS		$266,000	$266,000	
29	BROSTERHOUS ROUNDABOUT	ALL	LS		$224,000	$224,000	
B	SUBTOTAL					**$3,808,000**	
	W/ COUNTRY CLUB ROUNDABOUT					**$4,074,000**	
	W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS					**$4,298,000**	
C	ELEC/I&C	(% of B)				$0	
D	MECHANICAL	(% of B)				$0	
E	SUBTOTAL					**$0**	
F	ALLOWANCE =	(% of G)				$0	
G	MOB/BOND/INS. =	(% of G)				$0	
H	CONTINGENCY =	30%				$1,143,000	
	W/ COUNTRY CLUB ROUNDABOUT	30%				$1,223,000	
	W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS	30%				$1,290,000	
I	SUBTOTAL					**$4,951,000**	
	SUBTOTAL W/ COUNTRY CLUB ROUNDABOUT					**$5,297,000**	
	SUBTOTAL W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS					**$5,588,000**	
J	ENGINEERING	20%				$990,200	
	ENGINEERING SUBTOTAL W/ COUNTRY CLUB ROUNDABOUT	20%				$1,059,400	
	ENGINEERING W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS	20%				$1,117,600	
	CAPITALIZED INTEREST (BOND)	(% of I)				$0	
	COB INTERNAL CHARGES	(% of I)				$0	
	OTHER COB COSTS	(% of I)				$0	
K	ADMIN/LEGAL	(% of I)				$0	
L	PROPERTY COSTS (ROW/EASEMENTS) Assumed Cost	87,160	SF		$10.00	$871,600	
	W/ COUNTRY CLUB ROUNDABOUT	98,060	SF		$10.00	$980,600	
	W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS	104,260	SF		$10.00	$1,042,600	
M	UTILITIES COSTS					$0	
N	PERMIT FEES					$0	
	Total Estimated Project Cost					**$6,813,000**	
	W/ COUNTRY CLUB ROUNDABOUT					**$7,337,000**	
	W/ COUNTRY CLUB AND BROSTERHOUS ROUNDABOUTS					**$7,749,000**	

NOTES

1 Note: if this work is in the unit price bid schedule then use 0% and note this.
2 Note: if this work is in the unit price bid schedule then use 0% and note this.
3 Varies depending upon the 30%, 60% 95% design level.
4 Discuss with consultant and CIP mgr for percentage during planning.
5 This will vary by project in coordination with the funding mgr.
6 Pavement quantities are based on an assumed roadway section of 6" of HMAC and 12" of Aggregate Base.
7 Water quality facility unit cost includes seeding and limited plantings.