District Highway Maintenance Research-On-Call (ROC) 2023-09 Task #8: Improving the Process of Removing Totem Poles

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Prepared for:
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Office of Statewide Planning & Research

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August 2023

Final Report

University of CINCINNATI

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

RESEARCH

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16. Abstract

Roadside vegetation management can be a time-consuming and potentially dangerous task, particularly on steep embankments typical of unglaciated regions in Ohio. Furthermore, tree clearing is usually undertaken during difficult weather conditions (i.e., snowy, icy) as regulations for agencies that receive federal funding limit clearing to protect habitat for the Indiana and northern long-earned bat species. The combination of steep and unstable terrain can slow progress and expose workers to difficult working conditions with higher risk for accidents.

A literature review was conducted and a range equipment solutions were identified. A excavator with grapple saw attachment was identified as the preferred equipment due to anticipated performance, availability, and versatility. ROI was calculated using a variety of assumptions and the payback period ranged from 1.2 to 3.6-years. In addition, other ODOT Districts indicated that similar improvements are needed for their tree removal process to improve production and reduce hazards.

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1. Problem Statement

Roadside vegetation management can be a time-consuming and potentially dangerous task, particularly on steep embankments typical of unglaciated regions in Ohio. Furthermore, tree clearing is usually undertaken during difficult weather conditions (i.e., snowy, icy) as regulations for agencies that receive federal funding limit clearing to October 1st through March 31st to protect habitat for the Indiana and northern long-earned bat species. The combination of steep and unstable terrain can slow progress and expose workers to difficult working conditions with higher risk for accidents.

Workers in ODOT District 11 have developed an efficient process to clear roadside trees. Unfortunately, the process leaves boles, often referred to as totem poles, in place to protect tree trimming equipment from damage that would occur if tree saw blade contacted the ground. Bole removal is currently completed by manual labor with workers traversing slopes with chainsaws. In some cases, boles cannot be removed due to worker safety concerns (e.g. accessibility; proper equipment, site conditions, etc.) and can eventually become hazards to wildlife and the travelling public. Furthermore, abandoned boles make the job look unfinished leading to public criticism.

2. Research Background

The overall goal of the research-on-call project was to identify opportunities to improve the efficiency and safety of the roadside vegetation management process with a particular focus on removal of totem poles. This research goal was addressed through the following research objectives:

1. Document the current tree removal process and identify opportunities for improvement.
2. Conduct a literature review to identify other methods and equipment used in roadside vegetation management.
3. Identify potential solutions and conduct detailed research on equipment options to reduce labor requirements and improve worker safety.

The literature review (Objective #2) identified several methods and equipment options utilized in other states or industry. The options and their key strengths and weaknesses for use in this project are outlined in Table 1.

Table 1. Equipment options and positive/negative aspects.

Equipment	Positive	Negative
Excavator w/attachment	• Versatility for year-round use • Adequate capacity when extended	• Moderate reach • Footprint of larger capacity excavators
Telehandler w/attachment	• Mobility • Extended reach	• Specialized equipment • Limited capacity when extended
Skid steer w/attachment	• Already on inventory • Multiple uses • Range of available attachments	• Limited ability to traverse steep terrain • Limited lift capacity on uneven terrain
Bucket truck	• Extended reach • Already in inventory	• Worker exposure • Slow progress
All-terrain mini-lift	• Low-cost	• Worker exposure • Slow progress
Forestry harvester (e.g., Sennebogen)	• Mobility • Reach	• Specialized equipment • High cost • Capacity when extended
Knuckle boom crane	• Reach • Multiple uses	• High cost • Capacity when extended
Forestry mulcher	• Multiple uses • Already in inventory	• Limited ability to traverse steep terrain • Lower production rate
Spider excavator	• Mobility on rough terrain • Multiple uses	• Requires high skill level to operate • High cost
Attachment–feller buncher	• Range of options • Adequate cut width	• Higher weight • Requires larger carrier
Attachment–grapple saw	• Lower weight • Adequate cut width	• Requires additional hydraulic circuit • Specialized attachment
Attachment-shear	• Lower cost • Lighter weight	• Limited cut width • Requires high pressure

3. Research Approach

The initial stages of the project focused on gaining an understanding of the current tree removal process and identifying any safety concerns for managers and workers as well as bottlenecks that potentially limit production efficiency. The tree removal process was observed on multiple occasions along Interstate 77 north of Newcomerstown, OH in Tuscarawas County. Additionally, members of the TAC identified numerous sites with difficult work conditions and accompanied the researchers to multiple sites to discuss challenges, concerns, constraints, and variations in implementation at the county level. The research team also conducted informal interviews of highway technicians in the field to gather feedback on issues with the current process and to identify suggestions for improvement.

We conducted a comprehensive examination of current procedures and standards for removing and handling roadside trees from multiple sources, such as federal and state agencies, international organizations, trade associations, private industries, utilities, and municipalities. Our research into tree removal methods involved a diverse range of resources, including published reports, information posted on agency and industry websites, and the body of academic literature. We then summarized and discussed potential management solutions and tree removal equipment options with the TAC to assess their applicability for this project. Our study encompassed various factors, including the environmental conditions and terrain for tree removal, the skills and capabilities of workers, safety protocols, and the adaptability of equipment for other purposes.

After preliminary review, the research focus was narrowed to mid-sized excavators with various attachments. Attachments included feller bunchers, grapple saws, and forestry mulchers. Initial research focused on excavator attachments to identify options and technical specifications for the equipment. In total, 10 manufacturers of feller bunchers and grapple saws were identified with 31 total models under consideration. Technical specifications that were extracted from product literature included attachment weight, operating pressure, hydraulic flow capacity, grapple opening width, saw cut width, required size of the carrier, and angular rotation of the attachment. In addition, 8 manufacturers of forestry mulchers were identified with 40 models under consideration. Technical specifications that were extracted from product literature included attachment weight, operating pressure, hydraulic flow capacity, cut width, required size of the carrier, and maximum material size. Links to manufacturer websites for the products were identified and summarized. Technical specifications were downloaded and archived. Finally, local dealers were identified along with their contact information.

Following evaluation of attachments, the grapple saw attachment was selected for further investigation. A field demonstration of the R/F 2078 (Ryan's Equipment) was organized with a local contractor (Kraig Slutz; Ohio Erie Excavating; Bolivar, OH) to observe machine capabilities firsthand. The demonstration included removal of multiple trees from a hillslope similar to the typical scenario for roadside tree removal. The demonstration confirmed that this would be a good option moving forward. To determine if this equipment was already owned by ODOT, we searched the Statewide Equipment Inventory to determine the availability of similar equipment, which was very limited and included no instances of a grapple with saw attachment.

After identification of the preferred attachment, a carrier (i.e., excavator) that was well suited to meet the pressure, flow, and lift capacity requirements for the attachment needed to be identified. Additionally, the excavator needed to meet reach requirements and not exceed size thresholds for transport or operation on narrow two-lane state routes. In total, the research team identified 10 manufacturers of mid-sized excavators (20-30 metric ton range) including 51 total models. The models included standard monoblock booms, long reach booms, and variable angle boom configurations on standard and short tail-swing bodies. Technical specifications that were extracted from the product literature included: carrier weight, engine horsepower, carrier length, carrier width, tail swing radius, maximum reach, and maximum digging depth. Due to concerns over road and lane closures on two-lane roads we focused further research on models that had a short tail swing radius.

To investigate and compare the capabilities of various excavator models, we developed several spreadsheet tools to explore and compare the reach and capacity of those models. One spreadsheet utilized dimensions of the excavator including various configurations of the boom and stick to explore the operational range and reach. Additionally, we conducted a GIS analysis of roadside terrain using LiDAR data to identify representative slope lengths and angles that would be encountered in the field. This approach was utilized as a quick and low-cost alternative to field surveying of the terrain. Additionally, a spreadsheet was developed to graph and compare 3 excavator models to visualize differences in reach and lifting capacity once fully extended into multiple positions above or below the ground surface. Finally, we developed a spreadsheet to calculate the weight of standing timber, which considers the length and diameter of the tree as well as the species of tree and density of the wood. Collectively, these tools were used to determine the size (length and diameter) of tree that could be cut when the excavator was extended into various working positions.

The researchers worked with 4 vendors to obtain quotes on one attachment and three excavator models. This information was then used to conduct a simple economic analysis and determine potential ROI for the equipment. To this end, work orders for ODOT roadside vegetation performed by different county garages in District 11 were obtained. For each work order the cost administrator(s) was separated from the total number of workers for each working day. The labor cost without administrator(s) was computed for the current process and new method that uses identified equipment. The cost administrator was then added. The equipment cost for the new process was computed by adding the additional hourly cost of the identified equipment. The total costs of the current and new process were determined. Based on that, the savings was estimated to range between $1,370 and $4,081 for each of the day of using the new tree removal process. Assuming that roadside tree removal is performed 60 days every year, it is estimated that the payback period for the identified equipment will range between 1.2 to 3.6 years. Based on a 10 year analysis period, the estimated return of investment (ROI) of 89% to 356%.

As the new process based on using identified equipment will improve the safety of ODOT during tree removal employees, analysis was conducted to estimate the potential cost saving due to that. To this end, the ODOT employees' injuries related to tree removal that occurred during the past three years were obtained from ODOT safety department. It was found that a total of six injuries occurred during the past three years; with an average of two injuries per year. While ODOT will not pay the direct cost of these injuries, the Department will cover indirect cost due disruption, recovery of lost productivity, administrative time spent by human resources and safety personnel as well as supervisors due to any injury incident. Occupational Safety and Health Administration's (OSHA) Safety Pays Program tool (https://www.osha.gov/safetypays/estimator) was used to estimate the indirect cost. Based on that, it is estimated that ODOT annual savings due to improving the safety of the tree removal process will range between $66,000 to $165,000.

Finally, the researchers reached out to multiple ODOT Districts (5, 9, and 10) in forested areas of the state to determine if the research findings of this study were more broadly applicable. The survey attempted to document the frequency, extent, and timing of tree removal; details regarding the process for tree removal; safety concerns; and, identify suggestions for process improvement.

4. Research Findings and Conclusions

Roadside tree removal is an equipment and labor-intensive process. The current process in ODOT District 11 utilizes a Jarraff Industries tree trimming saw with a telescoping boom and rotating head. The saw blade is 24-inches in diameter and cannot make single cuts >12-inches, which results in boles being left in place. Cut limbs and small trees are removed from the slope using an

excavator, which places the debris on or near the road shoulder. Debris is then fed into a Bandit self-propelled chipper with grapple attachment that minimizes worker exposure at the chipper intake. Mulch is typically spread on site along the slope. Each piece of equipment requires a single operator.

Removal of boles is then undertaken by a team of highway technicians that traverse slopes with chainsaws to cut boles at the base. A team of ~2-6 is typically needed depending on the number and size of trees on the slope and extent of understory brush that cannot be removed by the tree saw. Boles and brush are pushed down the slope and gathered by a skid steer with grapple bucket. Small debris is taken forward to be chipper while larger debris is stockpiled in a safe place for later removal. A final pass is made by an excavator with forestry mulcher attachment to grind stumps level with the ground giving the site a clean, finished appearance. In addition to work on the slope, the process also requires maintenance of traffic and site cleanup at the end of the day.

The main findings of the research are summarized in the bulleted list that follows. Additional details on the current process and results of the literature review are included in Appendix A. A summary of feller buncher and grapple saw attachments are included in Appendix B. Details on forestry mulcher attachments are available in Appendix C. Results on a terrain analysis and roadside slope characteristics is provided in Appendix D. Additionally, conceptual diagrams of the current and proposed tree removal process is provided in Appendix D. Results of a preliminary cost-benefit analysis are provided in Appendix E. Summary data on excavators is provided in Appendix F. A comparison of reach length, lift capacities, and cost for select excavators is provided in Appendix G. Summary results for interviews with other Districts is provided in Appendix H. Primary findings of the research are summarized as follows:

- Increases in production rates for tree removal are needed to the maximum extent possible due to a backlog of maintenance and impacts of fallen trees on roadway infrastructure (i.e., pavement, guardrails, etc.) and motorist safety.
- Safety is a major concern and tree removal is a common source of reported accidents and worker injuries.
- ODOT has developed an effective and efficient tree removal process that would likely benefit by replacing manual removal of totem poles by mechanical means.
- Similar equipment is not currently available in ODOT inventory.
- Multiple ODOT Districts would benefit from the outcomes of future research on this topics as their processes are similar to District 11.

    - Two Districts have tree saws and averages 200+ days/year in the field.
    - One District has capability to remove roadside trees, but frequently utilizes a tree service due to a shortage of workers.
    - Currently several Districts are utilizing the same tree service for canopy clearing which is economical.
    - The tree service company has not been utilized them for full tree removal, which is the focus of this study.
- General consensus amongst other Districts is that additional research is of interest and could result in changes to their roadside tree removal process.
- The estimated payback period for the identified equipment will range between 1.2 to 3.6 years with a return of investment (ROI) of up to 356% based on a 10-year analysis period.
- ODOT annual savings due to improving the safety of the tree removal process was estimated to be up to $165,000.

5. Recommendations for Implementation

Based on the results of the survey, we recommend the following:

- ODOT should consider purchasing an excavator and grapple saw attachment for further research and field testing in District 11.
    - The grapple saw (e.g., Ryan's Equipment F/R 2078) should have a large grapple opening and cut width so it can be used to remove larger trees on slopes. Larger trees, although less common, pose a greater risk of severe injury to workers.
    - Pair the grapple saw with a mid-sized excavator between 20-30 metric tons to meet hydraulic pressure and flow needs, reach, lift capacity, and transport requirements.
    - Excavator should have a short tail swing radius to minimize disruption to traffic on two-lane roadways.
    - Additional hydraulic lines and electrical circuit upgrades may be needed on standard excavators to properly operate the grapple saw attachment.
- Organize and conduct field trainings for equipment operations specific to tree removal with a grapple saw.
- Organize necessary safety training with vendors and ODOT safety staff. Create training materials.
- Conduct time and motion studies to assess the impact of new equipment on production rates.

- Assess changes to worker safety due to new process.
- Conduct a detailed cost-benefit analysis to evaluate equipment ROI.

6. Appendices

Appendix A

ODOT Research-On-Call
Task #8
Update #1
3/6/2023

Current Process – Jarraff Tree Trimmer

Current Process – Bandit Self-Propelled Chipper

Current Process – Manual Pole Removal

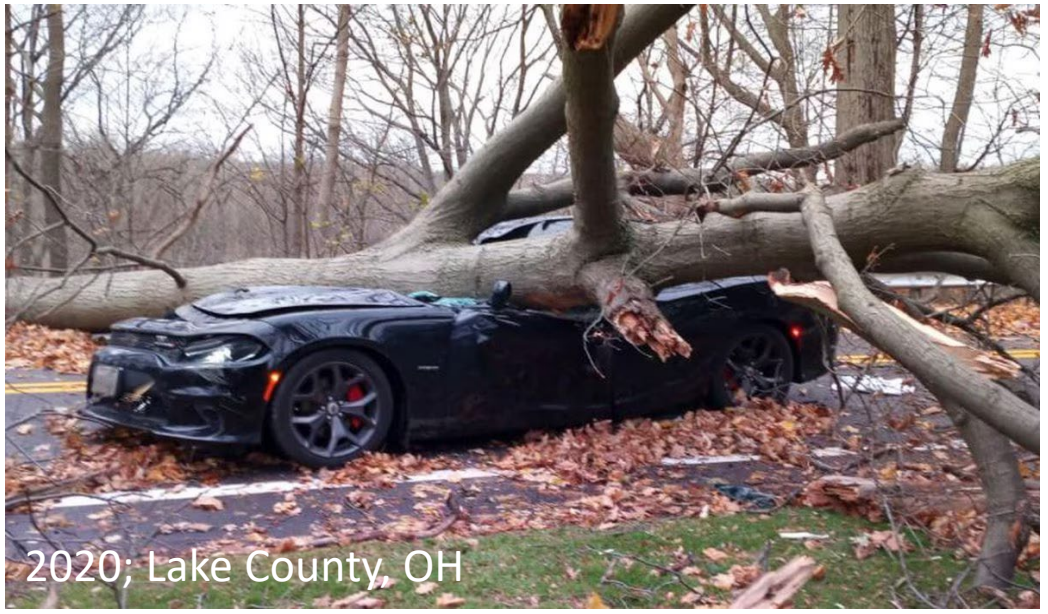
Current Process – Debris Removal

Current Process – Forestry Mulching (Promac)

District Goals

- Safety
  - Worker
  - Roadway
    - Downed trees and limbs (2)
- Production Efficiency
  - Difficult to Meet All Demands
  - Constrains Options (ABC, TCH)
- Multi-Purpose Equipment
  - Oct-Apr
- Right-Sized and Transportable
- Cost-Effective


2022; Holmes County, OH


2020; Lake County, OH

Issues – Guardrail/Roadway Damage

Utilities

- Little need for tree removal around utilities
  - AEP - $50M annual expenditures in Ohio for tree removal (The Columbus Dispatch; 2018)

Literature Review

- Bucket Truck
- Crane – Worker Platform
- Tree Care Handler (Sennebogen)
- All-Terrain Tracked Mini-Lift
- Forestry Wheeler Harvester
- Feller Buncher Attachments
- Knuckleboom Crane w/Grapple Saw
- Forestry Mulcher
- Shear Attachment

Fixed Rotating Grapple Saw (59”-78”)

MODELS	70" Fixed Grapple Saw
Max Opening	70"
Single Cut Capacity	28"
Saw Bar	37"
Saw Chain	3/4" Pitch
Sprocket	9 Tooth
Chain Oil Reservoir	3 Gallon
Weight	2,500 lbs
Hydraulic Flow	25-45 gpm
Hydraulic PSI Req.	3,500 - 4,000 psi
Carrier	12-20 ton

Dangle Saw (28”-42”)

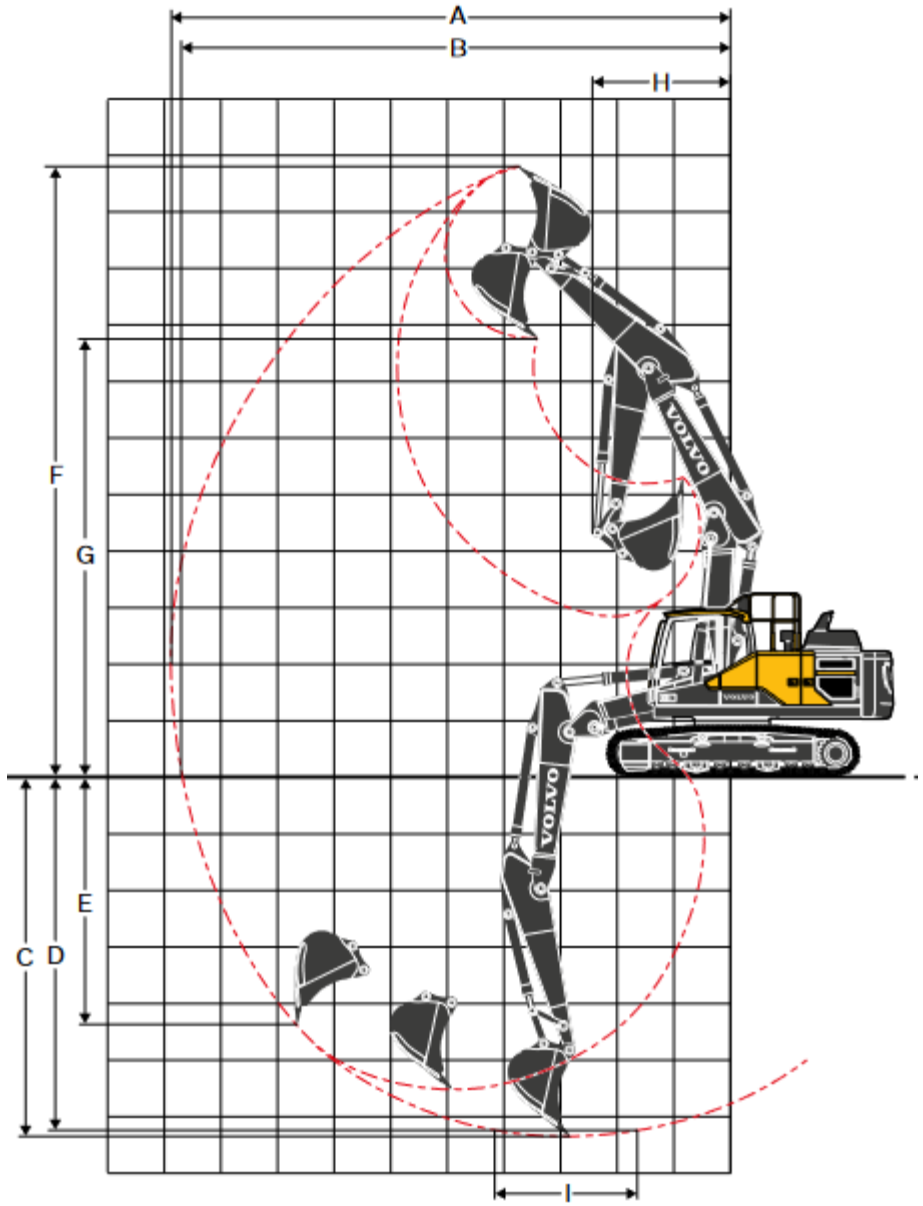
MODELS	DS28C
Max Opening:	38"
Single Cut Cap.:	30"
Saw Bar:	37"
Saw Chain:	3/4 pitch
Sprocket:	9 tooth
Chain Oil Res.	8 gal
Rotator:	Rotobec R6500
Motor:	45cc
Weight:	3200 lbs
Carrier:	14-25 ton excavator

Initial Thoughts

- Supplement Existing Process
- Where it fits
  - TBD
- Test before close of trimming season (April 1)?
  - Ryan's Equipment (2 meetings)
  - Yoder Hydraulics
    - Apple Creek, OH
    - Just installed Ryan's Dangle Saw

Telehandlers (Merlo/Magni) or Skid Steer

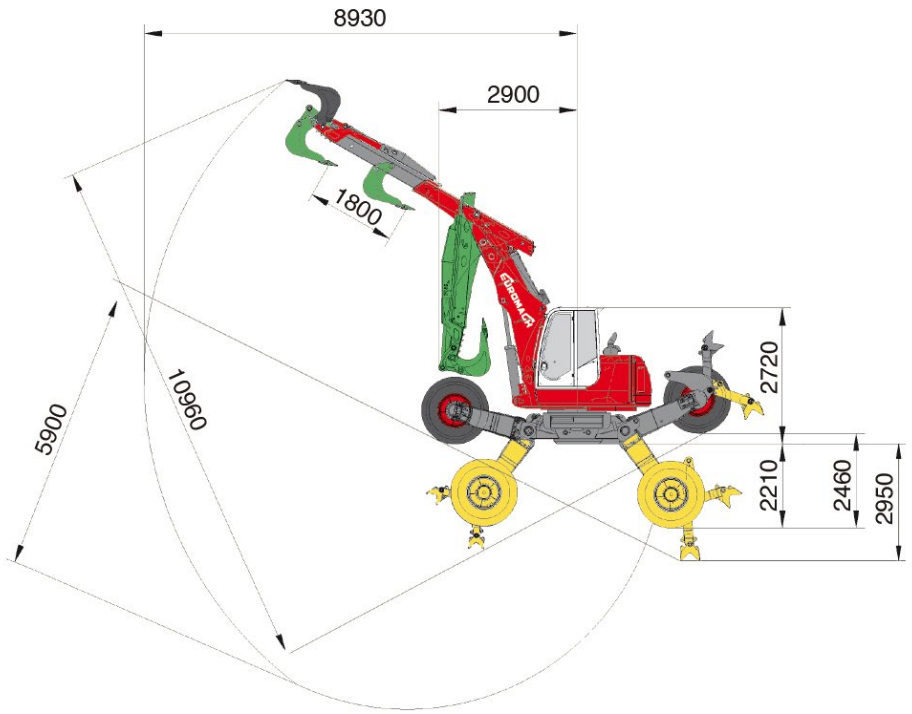
Excavator w/ Two-Piece Boom



WORKING RANGES								
Description	**Unit**							
Boom	**m**	**ft in**	**5.57 (18'3") 2-piece**					
Arm	**m**	**ft in**	**2.5**	**8'2"**	**2.9**	**9'6"**	**3.5**	**11'6"**
A. Max. digging reach	mm	ft in	9 450	31'0"	9 840	32'3"	10 310	33'10"
B. Max. digging reach on ground	mm	ft in	9 280	30'5"	9 670	31'9"	10 150	33'4"
C. Max. digging depth	mm	ft in	5 900	19'4"	6 300	20'8"	6 850	22'6"
D. Max. digging depth (2.44 m / 8' level)	mm	ft in	5 790	19'0"	6 200	20'4"	6 750	22'2"
E. Max. vertical wall digging depth	mm	ft in	4 990	16'4"	5 410	17'9"	5 930	19'5"
F. Max. cutting height	mm	ft in	10 380	34'1"	10 710	35'2"	10 920	35'10"
G. Max. dumping height	mm	ft in	7 460	24'6"	7 780	25'6"	8 010	26'3"
H. Min. front swing radius	mm	ft in	2 740	9'0"	2 470	8'1"	2 730	8'11"

Spider/Walking Excavator

Spider/Walking Excavator



TECHNICAL FEATURES

Operative weight	16000 Kg (Big Foot); 17500 Kg (Forester)
Engine's model	John Deere 6068HF485 Tier 3 A
Engine's type	Diesel four strokes water cooled
Engine size	6800 (cc)
Max power	198 kW (266 HP)
Potential difference	24 V
Max arm extension	8930 mm
Total pumps flow	508 lit/min
Penetration force	83 KN
Break off force	133 KN

Information Needs
Roadway Service Manager Contacts

- District 4 - ?
- District 5 - ?
- District 8 - ?
- District 9 - ?
- District 10 - ?
- District 11 - ?

Appendix B

Feller Buncher Attachments for Excavators

ODOT Research-On-Call Task #8

Submitted: April 10, 2023

Submitted by: Jon Witter

Brand: Waratah
Type: Feller Attachment (Bar Saw)
Models: FL85/FL95/FLFL100

WARATAH	FL85 Series II	FL95	FL100
Weight (lbs)	3851	5776	6600
Pressure (psi)	3625	5076	5076
Capacity (gpm)	58	53	79
Grapple Opening (in)	43	62	57.8
Cut Width (in)	36	39	39.3
Carrier Size (mt)	20-27	30+	30+
Rotation (°)	360	360	360
Cost ($)			

Brand: Ryan's Equipment
Type: Fixed/Rotating Grapple Saw (Bar)
Models: 2059/2070/2078

Ryan's Equipment	2059	2070	2078
Weight (lbs)	1500	2500	3900
Pressure (psi)	3500-4000	3500-4000	3000-4000
Capacity (gpm)	25-45	25-45	25-40
Grapple Opening (in)	59	70	78
Cut Width (in)	20	28	35
Carrier Size (mt)	8-12	12-20	21-26
Rotation (°)	360	360	360
Cost ($)			

Brand: Ryan’s Equipment
Type: Dangle Saw (Bar Saw)
Models: DS20/DS28C/DS3550

Ryan's Equipment	DS20	DS28C	DS3550
Weight (lbs)	1500	3200	4000
Pressure (psi)	NA	NA	NA
Capacity (gpm)	NA	NA	NA
Grapple Opening (in)	28	38	42
Cut Width (in)	20	30	35
Carrier Size (mt)	10-5	14-25	20-30
Rotation (°)	NA	NA	NA
Cost ($)			

Brand: Quadco
Type: Feller Attachment (Bar Saw)
Models: QB2500/QB3200/QB3500/QB4400

Quadco	QB2500	QB3200	QB3500	QB4400
Weight (lbs)	3858	5400	5400	6820
Pressure (psi)	4350	NA	4350	4350
Capacity (gpm)	66	NA	66	66
Grapple Opening (in)	26	NA	43.3	55
Cut Width (in)	25	32	34	39 or 44
Carrier Size (mt)	20-24	25	24-28	30-35
Rotation (°)	360	360	360	360
Cost ($)				

Brand: SATCO
Type: Feller Attachment (Bar Saw)
Models: SAT420/SAT630

SATCO	SAT420	SAT630
Weight (lbs)	3100	4400
Pressure (psi)	4000	4000
Capacity (gpm)	53	53
Grapple Opening (in)	38	50
Cut Width (in)	25	34
Carrier Size (mt)	16-24	24-40
Rotation (°)	360	360
Cost ($)		

Brand: Tigercat
Type: Fixed Feller Attachment (Bar Saw)
Models: 5185

Tigercat	5185
Weight (lbs)	4300
Pressure (psi)	NA
Capacity (gpm)	NA
Grapple Opening (in)	51
Cut Width (in)	33
Carrier Size (mt)	LX830E (35mt)
Rotation (°)	NA
Cost ($)	

Brand: Tigercat
Type: Directional Feller (Bar Saw)
Models: 5195

Tigercat	5195
Weight (lbs)	5740
Pressure (psi)	NA
Capacity (gpm)	NA
Grapple Opening (in)	54
Cut Width (in)	37.5
Carrier Size (mt)	S855E (27mt)
Rotation (°)	NA
Cost ($)	

Brand: Timberpro
Type: Feller Attachment (Bar Saw)
Models: TBS-32

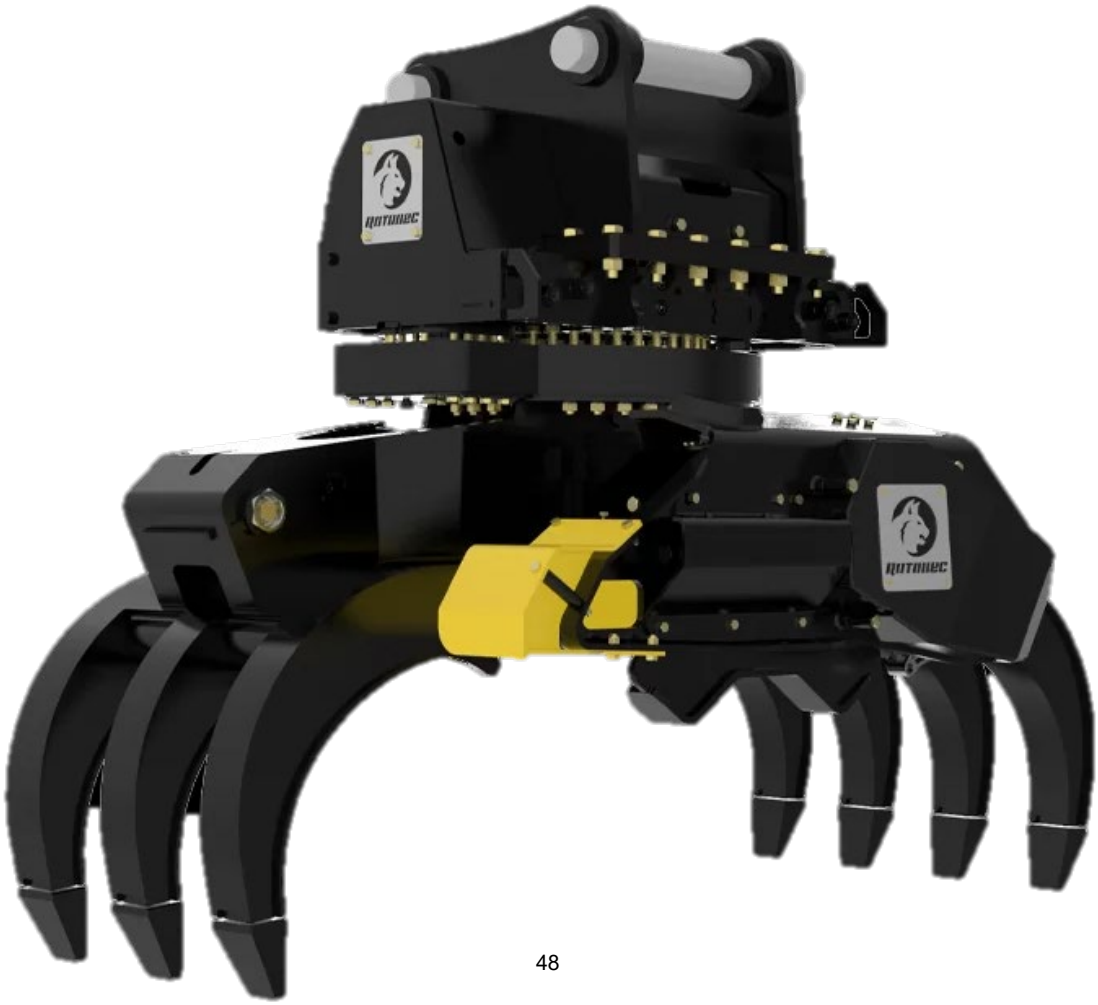
Timberpro	TBS-32
Weight (lbs)	5200
Pressure (psi)	NA
Capacity (gpm)	NA
Grapple Opening (in)	36
Cut Width (in)	32
Carrier Size (mt)	NA
Rotation (°)	360
Cost ($)	

Brand: Rotobec
Type: HD Grapple (Grapple Only)
Models: 4042HD/4048HD/4552HD/6058HD/6065HD

Rotobec	4042HD	4048HD	4552HD	6058HD	6065HD
Weight (lbs)	1385	1510	1730	1930	2715
Pressure (psi)	2500-5000	2500-5000	2500-5000	2500-5000	2500-5000
Capacity (gpm)	15-23	15-23	22-33	22-33	29-41
Grapple (in)	42	48	53	58	66
Cost ($)					

Brand: Rotobec
Type: SHD Grapple (Grapple Only)
Models: 4552SHD/4560SHD/6065SHD

Rotobec	4552SHD	4560SHD	6065SHD
Weight (lbs)	2765	2875	2965
Pressure (psi)	2500-5000	2500-5000	2500-5000
Capacity (gpm)	26-37	29-41	29-41
Grapple Opening (in)	53	60	66
Cost ($)			



Brand: Rotobec
Type: Grapple Saw (Saw Only)
Models: RGS404/RGS750

Rotobec	RGS404	RGS750
Weight (lbs)	443	670
Pressure (psi)	3500	3150
Capacity (gpm)	42	55
Bar Length (in)	39	45
Cost ($)		

Brand: Pierce
Type: Feller Attachment (Bar Saw)
Models: PBS3440

Pierce	PBS3440
Weight (lbs)	4780
Pressure (psi)	3600-5000
Capacity (gpm)	50-75
Grapple Opening (in)	39.5
Cut Width (in)	36
Carrier Size (mt)	30-41
Rotation (°)	350
Cost ($)	

Brand: Westtech
Type: Feller Attachment + Extension
Models: Woodcracker CS610/Woodcracker T

Westtech	Woodcracker CS610	Woodcracker T
Weight (lbs)	2200	1600
Pressure (psi)	3300-400	3600
Capacity (gpm)	17-29	13-29
Grapple Opening (in)	50	NA
Cut Width (in)	24	NA
Carrier Size (mt)	15-20	14-22
Rotation (°)	360	NA
Ext. Length (in)	NA	160
Cost ($)		

Links

- Waratah Feller Attachments
  - FL85 (https://www.brandt.ca/Divisions/Tractor/Products/Forestry-Attachments/Felling-Heads/FL85)
  - FL95 (https://www.brandt.ca/Divisions/Tractor/Products/Forestry-Attachments/Felling-Heads/FL95)
  - FL100 (https://www.waratah.com/product/fl100/)
- Ryan's Equipment
  - Fixed Rotating Grapple Saw (2059/2070/2078)
    - https://www.ryansequip.com/product/fixed-rotating-grapple-saw/
  - Dangle Saw
    - https://www.ryansequip.com/product/dangle-saw/
- Quadco Feller Attachment
  - QB2500 (https://www.quadco.com/product/qb2500/)
  - QB3200 (https://www.quadco.com/product/qb3200/)
  - QB3500 (https://www.quadco.com/product/qb3500/)
  - QB4400 (https://www.quadco.com/product/qb4400/)
- SATCO
  - SAT420 (https://www.satco.co.nz/satco-420-felling-loading-grapple.html)
  - SAT630 (https://www.satco.co.nz/satco-630-felling-grapple.html)
- Tigercat
  - 5185 (https://www.tigercat.com/product/5185-bar-saw/)
  - 5195 (https://www.tigercat.com/product/5195-directional-felling-head/)
- Timberpro
  - TBS-32 (http://timberpro.com/Brochures/TBS32-2018-web.pdf)
- Rotobec
  - Log Grapple (https://rotobec.com/attachments/products/log-grapple)
  - Grapple Saw (https://rotobec.com/attachments/products/rotobec-grapple-saw)
- Pierce Pacific
  - PBS3440 (https://piercepacific.com/products/forestry/felling-attachments/)
- Westtech
  - Woodcracker CS610 (https://www.woodcracker.com/prod/woodcracker-cs-compact/?target=_self)
  - Woodcracker T (https://www.woodcracker.com/prod/woodcracker-t/?target=_self)

Appendix C

Forestry Mulcher Attachments for Excavators

ODOT Research-On-Call Task #8

Submitted: April 10, 2023

Submitted by: Jon Witter

Brand: CAT
Models: HM208/HM210
Dealer(s): Ohio CAT (Bolivar/Cadiz)

CAT	HM208	HM210
Weight (lbs)	1080	1190
Pressure (psi)	2175-3626	2175-3627
Flow Rate (gpm)	18-34	18-35
Cut Width (in)	32.2	39.8
Carrier Size (mt)	NA	NA
Maximum Material Size (in)	8	NA
Cost ($)		

Brand: Ryan's Equipment
Models: Wood Hunter
Dealer(s): Ryan's Equipment (Edmore, MI)

Ryan's Equipment	Wood Hunter
Weight (lbs)	1080
Pressure (psi)	2175-3626
Flow Rate (gpm)	18-34
Cut Width (in)	32.2
Carrier Size (mt)	NA
Maximum Material Size (in)	8
Cost ($)	

Brand: FECON
Models: FMX28/FMX36/FMX50

Dealer(s): Southeastern Equipment Company (Cambridge)

FECON	FMX28	FMX36	FMX50
Weight (lbs)	750	850	1050
Pressure (psi)	4000	4000	4000
Flow Rate (gpm)	12-40	12-40	12-40
Cut Width (in)	28	36	50
Carrier Size (mt)	3.5-10	3.5-10	3.5-10
Maximum Material Size (in)	5	5	5
Cost ($)			

Brand: FECON
Models: CEM36/BH47EXC/BH62EXC

Dealer(s): Southeastern Equipment Company (Cambridge)

FECON	CEM36	BH47EXC	BH62EXC
Weight (lbs)	1450	2400	2750
Pressure (psi)	6000	6000	6000
Flow Rate (gpm)	17-40	27-50	27-75
Cut Width (in)	36	37	50
Carrier Size (mt)	8-15	12-20	12-20
Maximum Material Size (in)	6	8	8
Cost ($)			

Brand: FECON
Models: BH40EXC/BH80EXC/BH200EXC

Dealer(s): Southeastern Equipment Company (Cambridge)
Appears the FECON builds Brush Hound Equipment

FECON	BH40EXC	BH80EXC	BH200EXC
Weight (lbs)	3250	4300	5500
Pressure (psi)	6000	6000	6000
Flow Rate (gpm)	30-75	38-150	40-150
Cut Width (in)	36	56	59
Carrier Size (mt)	15-45	15-45	15-45
Maximum Material Size (in)	10	10	10
Cost ($)			

Brand: Denis Cimaf
Models: DAH-065B/ DAH-085B / DAH-080C
Dealer(s): Ag Pro (New Philadelphia)

Denis Cimaf	DAH-065B	DAH-085B	DAH-080C	DAH-100C
Weight (lbs)	1000	1200	1830	2000
Pressure (psi)	4000	4000	4000	5000
Flow Rate (gpm)	14	20	20	27
Cut Width (in)	26	34	32	42
Carrier Size (mt)	5-7	7-10	7-10	10-15
Maximum Material (in)	4	4	4	6
Cost ($)				

Brand: Denis Cimaf
Models: DAH-065B/ DAH-085B / DAH-080C
Dealer(s): Ag Pro (New Philadelphia)

Denis Cimaf	DAH-125D	DAH-150E	DAH-150Er
Weight (lbs)	2900	4100	4640
Pressure (psi)	5000	5000	6000
Flow Rate (gpm)	35	38	55
Cut Width (in)	48	57	57
Carrier Size (mt)	16-22	18-24.5	24.5-32
Maximum Material (in)	10	15	20
Cost ($)			

Brand: Seppi M.
Models: Super-BMS/BMS/BMS-F/BMS-L
Dealer(s): NA (West Chester, OH)

Seppi M.	BMS-L	BMS-F	BMS	Super-BMS
Weight (lbs)	1500-1700	1240-1580	2100-2570	5700
Pressure (psi)	2175-3626	3000-5077	3000-5076	2900-5076
Flow Rate (gpm)	23-40	23-49	23-48	53-98
Cut Width (in)	39/49	39/49/60	39/49/59	59
Carrier Size (mt)	7-15	10-20	15-30	25-45
Maximum Material (in)	3	8	12	16
Cost ($)				

Brand: FAE Group
Models: DML/HY 75/100/125; BL1/EX 75; BL2/EX 100/125; UML/HY 100/125/150
Dealer(s): FAE USA (Flowery Branch, GA)

FAE GROUP	DML HY	BL1	BL2	UML/HY
Weight (lbs)	915-1146	783	1257-1378	2072-2425
Pressure (psi)	2611-5076	2600-5080	2600-5080	2611-5076
Flow Rate (gpm)	13-36	13-37	26-37	24-45
Cut Width (in)	31/39/49	31	39/49	43/53/62
Carrier Size (mt)	5-13	4-7.5	8-14	9-15
Maximum Material (in)	5	5	6	6
Cost ($)				

Brand: FAE Group
Models: BL3/EX; UML/EX; BL4/EX;
Dealer(s): FAE USA (Flowery Branch, GA)

FAE GROUP	BL3	UML/EX	BL4
Weight (lbs)	2855-3020	2403-2822	2417-3638
Pressure (psi)	2600-5080	3191-5076	3200-5080
Flow Rate (gpm)	32-55	34-55	38-79
Cut Width (in)	53/62	43/53/62	53/62
Carrier Size (mt)	14-20	14-20	18-25
Maximum Material (in)	8	8	12
Cost ($)			

Brand: FAE Group
Models: UML/S/EX; BL5/EX; UMM/EX
Dealer(s): FAE USA (Flowery Branch, GA)

FAE GROUP	UML/S/EX	BL5	UMM/EX
Weight (lbs)	3197-3417	5236	4387-4850
Pressure (psi)	3200-5080	3481-5076	3500-5080
Flow Rate (gpm)	38-79	48-79	34-79
Cut Width (in)	53/62	62	53/62
Carrier Size (mt)	18-25	24-36	20-36
Maximum Material (in)	12	16	16
Cost ($)			

Brand: Promac
Models: HDM 36/48/60; HDF 36/48/60
Dealer(s): Ohio CAT (Bolivar/Cadiz)

CAT	HDM	HDF
Weight (lbs)		
Pressure (psi)	2800-3200	2800-3200
Flow Rate (gpm)	35-50	35-45
Cut Width (in)	36/48/60	36/48/60
Carrier Size (mt)	13-22+	13-22+
Maximum Material Size (in)	NA	NA
Cost ($)		

Brand: BRADCO
Models: MM36E/MM422/MM421
Dealer(s): Ohio CAT & Columbus Eq. (Cadiz)

BRADCO	MM36E	MM422	MM421
Weight (lbs)	1600	2920	NA
Pressure (psi)	4000	4000	3500-4000
Flow Rate (gpm)	35-50	35-45	28-60
Cut Width (in)	36	42	42
Carrier Size (mt)	NA	NA	NA
Maximum Material (in)	12	12	12
Cost ($)			

Brand: BRADCO
Models: MM60E/MM601
Dealer(s): Ohio CAT & Columbus Eq. (Cadiz)

BRADCO	MM60E	MM601
Weight (lbs)	1600	2920
Pressure (psi)	3000-5800	4500-5800
Flow Rate (gpm)	30-60	32-44
Cut Width (in)	60	60
Carrier Size (mt)	NA	NA
Maximum Material (in)	NA	8
Cost ($)		

Links

- CAT Mulcher Attachments
  - HM208
    - https://www.cat.com/en_US/products/new/attachments/mulchers/mulchers/1000031800.html#
  - HM210
    - https://www.cat.com/en_US/products/new/attachments/mulchers/mulchers/1000031803.html
- Ryan's Equipment
  - Wood Hunter
    - https://www.ryansequip.com/product/mulcher/
- FECON
  - Bullhog FMX28/FMX36/FMX60
    - https://fecon.com/product/mulching-head-3-10-ton/
  - Bullhog CEM36
    - https://fecon.com/product/excavator-8-15-ton/
  - Bullhog BH47EXC/BH62EXC
    - https://fecon.com/product/excavator-mulching-head-12-20-ton/
  - Bullhog BH40EXC/BH80EXC/BH200EXC
    - https://fecon.com/product/excavator-15-45-ton/
- Brushhound (Rebranded FECON Attachments)
  - FX26/FX36
    - https://valleytoolmfg.com/products/
- Denis Cimaf
  - DAH-O65B/085B/080C/100C/125D/150E/150Er
    - https://www.morbark.com/product/dah-boom-mounted-mulchers/
- Seppi M.
  - BMS-L
    - https://www.seppi.com/en-us/mulcher-mower-shredder-tiller-stump-grinder/excavator-mulchers/bms-l.html
  - BMS-F
    - https://www.seppi.com/en-us/mulcher-mower-shredder-tiller-stump-grinder/excavator-mulchers/bms-f.html
  - BMS
    - https://www.seppi.com/en-us/mulcher-mower-shredder-tiller-stump-grinder/excavator-mulchers/bms.html
  - Super-BMS
    - https://www.seppi.com/en-us/mulcher-mower-shredder-tiller-stump-grinder/excavator-mulchers/super-bms.html

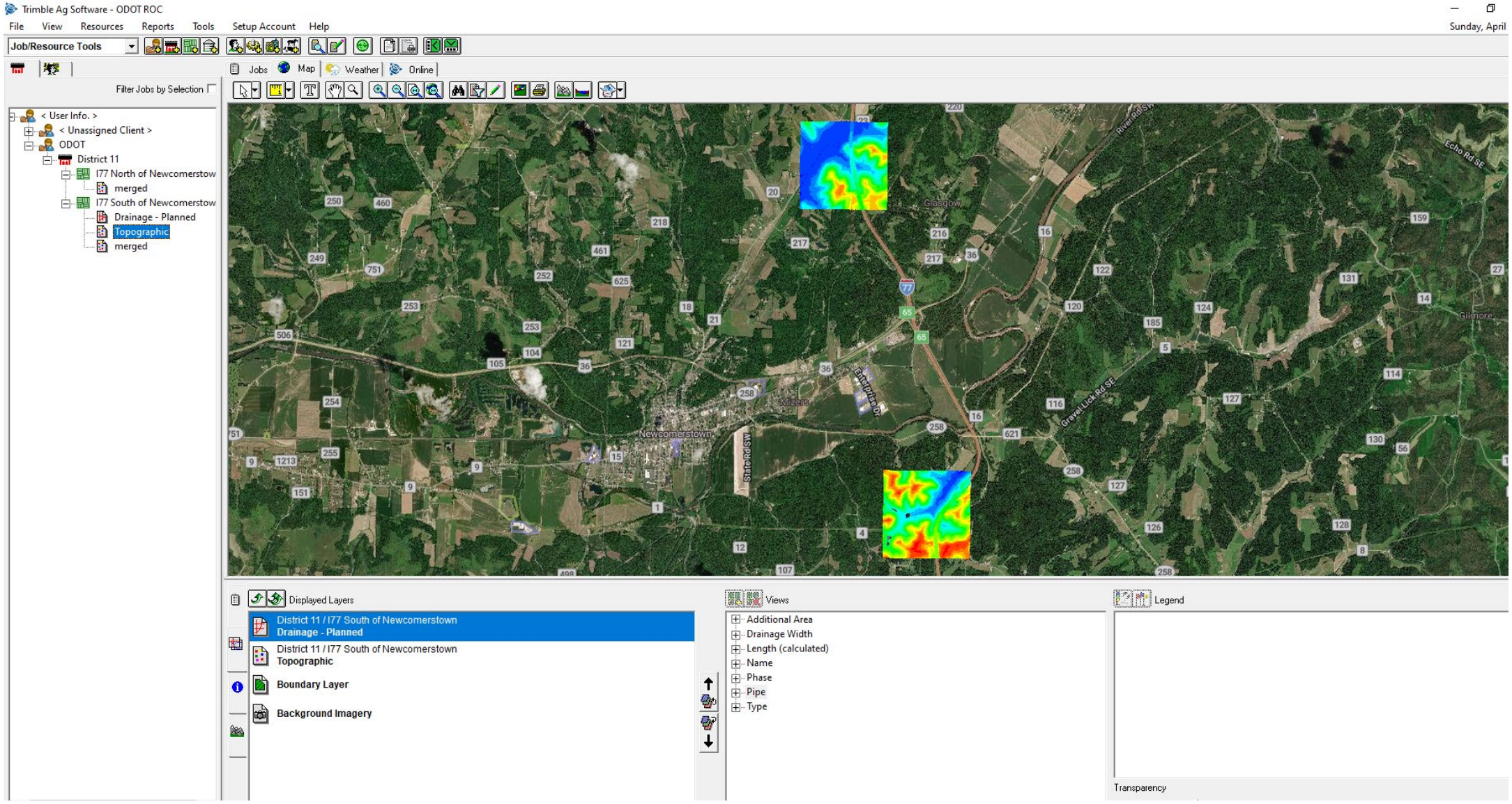
Links

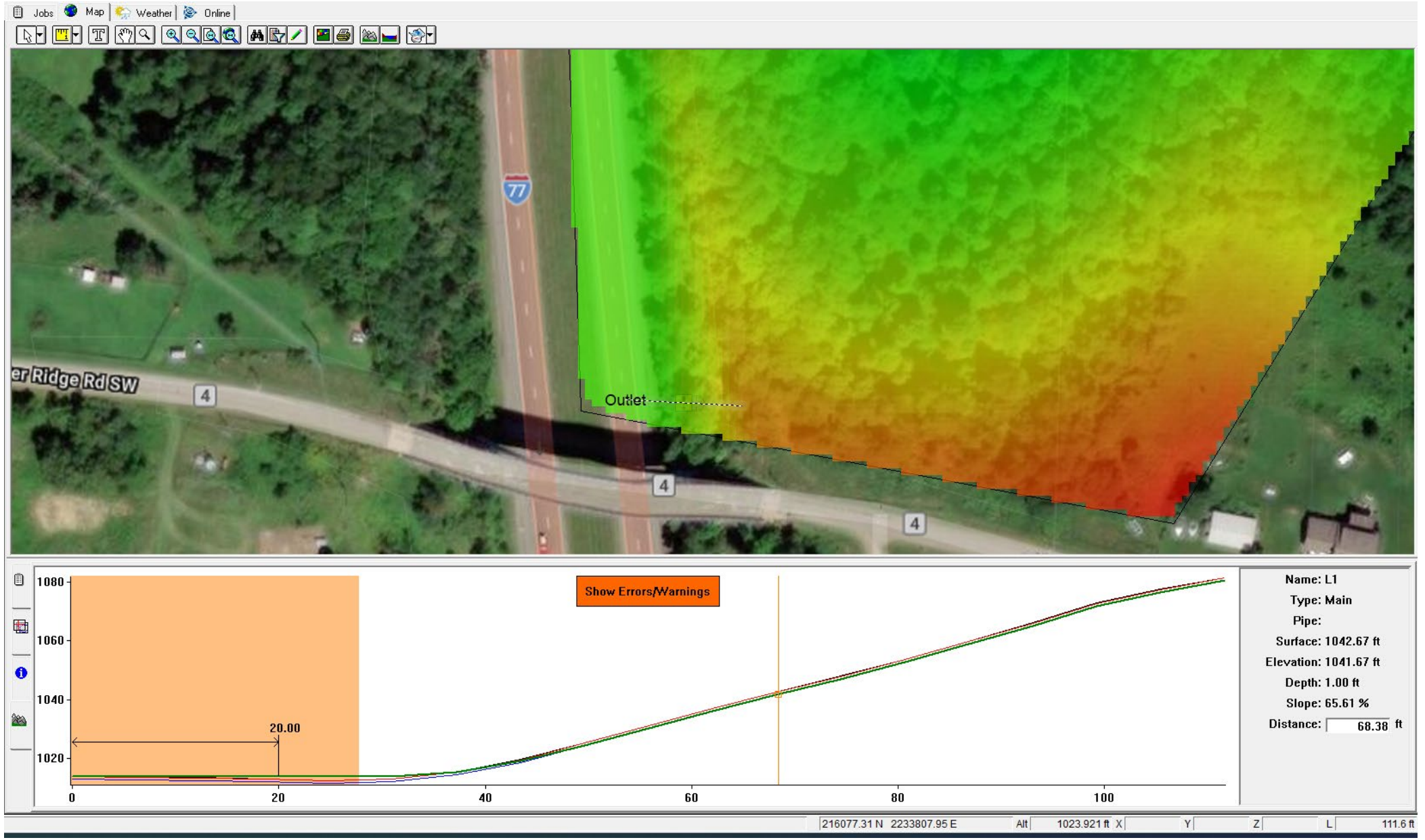
- FAE
  - DML/HY 75/100/125
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/dml-hy-dml-hy-vt
  - BL1/EX 75
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/bl1-ex-bl1-ex-vt
  - BL2/EX 100/125
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/bl2-ex-vt-bl2-ex-sonic
  - UML/HY 100/125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/uml-hy-vt-uml-hy-sonic-fml-hy
  - BL3/EX 125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/bl3-ex-vt-bl3-ex-sonic
  - UML/EX 100/125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/uml-ex-vt-uml-ex-sonic
  - BL4/EX 125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/bl4-ex-vt-bl4-ex-sonic
  - UML/S/EX 125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/uml-s-ex-vt-uml-s-ex-sonic
  - BL5/EX 150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/bl5-ex-vt-bl5-ex-sonic
  - UMM/EX 125/150
    - https://www.fae-group.com/en_US/products/land-clearing/hydraulic-driven-heads/forestry-mulchers-for-excavators/umm-ex-vt-umm-ex-sonic-umm-ex-vt-hp-umm-ex-hp-sonic
- Promac
  - HDM 36/48/60
    - https://promacequipment.ca/excavator-attachments/hdm/
  - HDF 36/48/60
    - https://promacequipment.ca/excavator-attachments/hdf/
- Bradco
  - MM36E
    - https://www.paladinattachments.com/products/bradco-excavator-mulcher-ii-mm36
  - MM422
    - https://www.paladinattachments.com/products/bradco-hd-ex-mulcher-mm422
  - MM421
    - https://www.paladinattachments.com/products/bradco-hd-ex-mulcher-mm421
  - MM60E
  - MM601
    - https://www.paladinattachments.com/products/bradco-hd-ex-mulcher-mm601

Appendix D

ODOT Research-On-Call
Task #8
Update #3
5/1/2023

Terrain Analysis – GIS and LiDAR



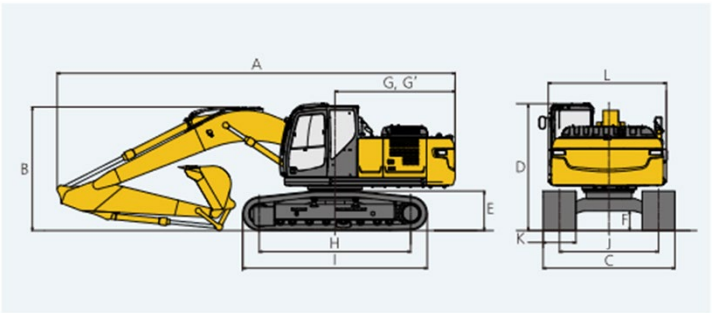

Jobs
Map
Weather
Online
77
4
Outlet
Show Errors/Warnings
1080
1060
1040
1020
20.00
0
20
40
60
80
100
Name: L1
Type: Main
Pipe:
Surface: 1042.67 ft
Elevation: 1041.67 ft
Depth: 1.00 ft
Slope: 65.61 %
Distance: 68.38 ft
216077.31 N 2233807.95 E
Alt 1023.921 ft X
Y
Z
L 111.6 ft

Slopes = 10%-65%

Working Ranges

Unit: ft-in{m}

Boom	18'6" {5.65 m}	
Arm / Range	Standard 9'8" {2.94 m}	Long 11'6" {3.5 m}
a- Max. digging reach	32'6" {9.90}	33'11" {10.34}
b- Max. digging reach at ground level	31'11" {9.73}	33'4" {10.17}
c- Max. digging depth	22'0" {6.70}	23'10" {7.26}
d- Max. digging height	31'11" {9.72}	32'10" {9.75}
e- Max. dumping clearance	22'8" {6.91}	22'10" {6.97}
f - Min. dumping clearance	8'0" {2.43}	6'2" {1.87}
g- Max. vertical wall digging depth	20'0" {6.10}	21'3" {6.47}
h- Min. swing radius	11'8" {3.55}	11'5" {3.48}
i - Horizontal digging stroke at ground level	17'3" {5.27}	19'11" {6.08}
j - Digging depth for 8 feet flat bottom	21'5" {6.52}	23'3" {7.08}
Bucket capacity SAE heaped cu.yd.{m³}	1.05 {0.8}	0.92 {0.70}



Dimensions

Unit: ft-in {mm}

Arm length		Standard 9'8" {2.94 m}	Long 11'6" {3.5 m}
A	Overall length	31'6" {9,600}	31'9" {9,670}
B	Overall heigth (to top of boom)	9'9" {2,980}	10'5" {3,170}
C	Overall width	10'5" {3,180}**	
D	Overall height (to top of cab)	10'0" {3,060}	
E	Ground clearance of rear end*	3'6" {1,060}	
F	Ground clearance*	1'6" {450}	
G	Tail swing radius	9'7" {2,910}	
G'	Distance from center of swing to rear end	9'6" {2,900}	
H	Tumbler distance	12'0" {3,660}	
I	Overall length of crawler	14'7" {4,450}	
J	Track gauge	7'10" {2,390}	
K	Shoe Width. In(mm)	24" (600)/28"(700)/31.5"(790) /35"(900)	
L	Overall width of upperstructure	9'4 {2,850}	

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E16 | 30

	Slope	x	y				slope	X	Y
	toe	5	0		Slope			34.7938398	25
	height		25	Tan	1:X				
	slope	40	0.69813	0.8391	**1.2**		square plot	34.7938398	-34.79383981
								-34.79384	34.79383981

	Guardrail	x	y
	Start	5	0
	End	5	3
	Culvert Diameter/Height	6	
	Culvert Invert Depth	10	
	Culvert Length	30	

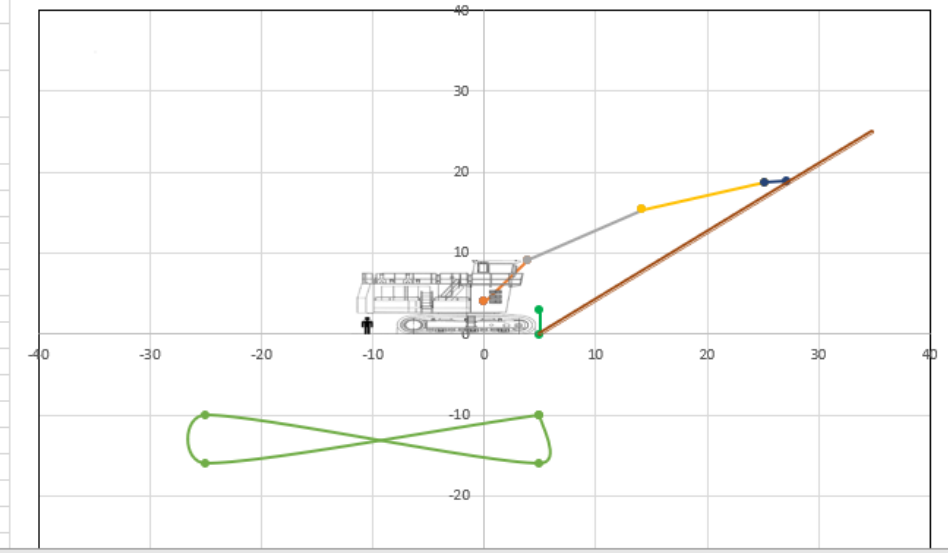
	Starting Point (FEET)	
	X	Y
	0	4

LENGTH			
INNER BOOM P1	0	FEET	Point 1
INNER BOOM P2	6.5	FEET	Point 2
OUTER BOOM	12	FEET	Point 3
STICK	11.5	FEET	Point 4
GRAPPLE	2	FEET	Point 5

							Y	X
ANGLE	ANGLE	BEARING	ADJUSTED BEARING	RADIANS	COSINE	SINE	Length * cos B	Length * sin B
INNER BOOM	37	37	37	0.64577	0.79864	0.60182	0	0
INNER BOOM	180	37	37	0.64577	0.79864	0.60182	5.191130815	3.91179765
OUTER BOOM	158	59	59	1.02974	0.51504	0.85717	6.180456899	10.28600761
STICK	166	73	73	1.27409	0.29237	0.9563	3.362274604	10.99750469
BUCKET	168	85	85	1.48353	0.08716	0.99619	0.174311485	1.992389396

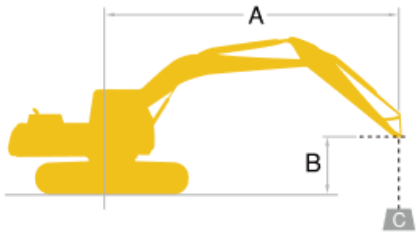
Coordinates		
Inner Boom P1	x	Y
Start	0	4
End	0	4
Inner Boom P2		
Start	0	4
End	3.91179765	9.191130815
Stick		
Start	3.91179765	9.191130815
End	14.1978053	15.37158771
Jib		
Start	14.1978053	15.37158771
End	25.19531	18.73386232
Bucket		
Start	25.19531	18.73386232
End	27.1876993	18.9081738

28 Inner Boom P1
29 Inner Boom P2
30 OUTER BOOM
31 JIB
33 BUCKET



Excavator Reach

Excavator Lift Capacity



Rating over front

Rating over side or 90 degrees

A – Reach from swing centerline to arm tip
B – Arm bucket pin height above/below ground
C – Lifting capacities in pounds (kilograms)

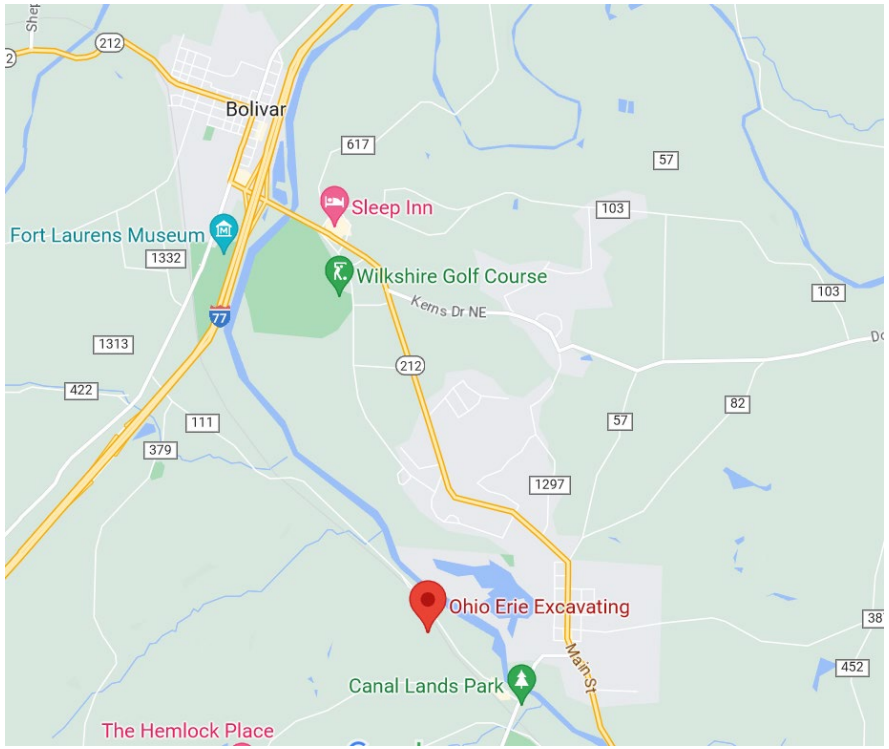
SK210LC		Standard Arm: 9'8"{2.94m}, no bucket, 2'7" {800mm} track shoes												
A / B		5'{1.5m}		10'{3.0m}		15'{4.6m}		20'{6.1m}		25'{7.6m}		AT MAX		Radius
25'{7.6m}	lb{kg}							*10,200{4,620}	*10,200{4,620}			*9,610{4,350}	*9,610{4,350}	20'2"{6.15}
20'{6.1m}	lb{kg}							*13,100{5,940}	11,980{5,430}			*8,840{4,000}	8,800{3,990}	23'11"{7.30}
15'{4.6m}	lb{kg}							*14,190{6,430}	11,600{5,260}	12,430{5,630}	8,130{3,680}	*8,630{3,910}	7,460{3,380}	26'3"{8.01}
10'{3.0m}	lb{kg}			*26,300{11,920}	*26,300{11,920}	*20,440{9,270}	16,850{7,640}	*16,020{7,260}	11,030{5,000}	12,180{5,520}	7,890{3,570}	*8,790{3,980}	6,790{3,070}	27'5"{8.37}
5'{1.5m}	lb{kg}					*24,160{10,950}	15,650{7,090}	16,610{7,530}	10,460{4,740}	11,880{5,380}	7,620{3,450}	*9,300{4,210}	6,540{2,960}	27'8"{8.45}
Ground Level	lb{kg}			*14,690{6,660}	*14,690{6,660}	25,460{11,540}	14,990{6,790}	16,150{7,320}	10,060{4,560}	11,660{5,280}	7,420{3,360}	*10,280{4,660}	6,670{3,020}	27'0"{8.25}
-5'{-1.5m}	lb{kg}	*15,120{6,850}	*15,120{6,850}	*25,260{14,450}	*25,260{11,450}	25,240{11,440}	14,810{6,710}	15,970{7,240}	9,900{4,490}	11,620{5,270}	7,390{3,350}	11,380{5,160}	7,250{3,280}	25'4"{7.74}
-10'{-3.0m}	lb{kg}	*26,470{12,000}	*26,470{12,000}	*32,150{14,580}	28,940{13,120}	*23,120{10,480}	14,970{6,790}	16,100{7,300}	10,010{4,540}			13,640{6,180}	8,630{3,910}	22'6"{6.86}
-15'{-4.6m}	lb{kg}			*23,560{10,680}	*23,560{10,680}	*17,120{7,760}	15,550{7,050}					*13,350{6,050}	12,320{5,580}	17'9"{5.41}

SK210LC		Long Arm: 11'6"{3.5m}, no bucket, 2'7" {800mm} track shoes												
A / B		5'{1.5m}		10'{3.0m}		15'{4.6m}		20'{6.1m}		25'{7.6m}		AT MAX		Radius
25'{7.6m}	lb{kg}											*8,220{3,720}	*8,220{3,720}	22'1"{6.74}
20'{6.1m}	lb{kg}									*9,180{4,160}	8,480{3,840}	*7,720{3,500}	*7,720{3,500}	25'7"{7.81}
15'{4.6m}	lb{kg}							*12,960{5,870}	11,950{5,420}	*12,150{5,510}	8,350{3,780}	*7,620{3,450}	6,960{3,150}	27'9"{8.47}
10'{3.0m}	lb{kg}			*27,830{12,620}	*27,830{12,620}	*18,600{8,430}	17,520{7,940}	*14,920{6,760}	11,350{5,140}	12,430{5,630}	8,070{3,660}	*7,820{3,540}	6,370{2,880}	28'11"{8.82}
5'{1.5m}	lb{kg}			*17,260{7,820}	*17,260{7,820}	*22,780{10,330}	16,170{7,330}	16,970{7,690}	10,710{4,850}	12,080{5,470}	7,750{3,510}	*8,320{3,770}	6,130{2,780}	29'2"{8.89}
Ground Level	lb{kg}			*17,780{8,060}	*17,780{8,060}	*25,330{11,480}	15,300{6,930}	16,420{7,440}	10,220{4,630}	11,790{5,340}	7,490{3,390}	*9,220{4,180}	6,210{2,810}	28'6"{8.7}
-5'{-1.5m}	lb{kg}	*14,800{6,710}	*14,800{6,710}	*24,970{11,320}	*24,970{11,320}	25,540{11,580}	14,950{6,780}	16,130{7,310}	9,970{4,520}	11,660{5,280}	7,360{3,330}	10,500{4,760}	6,670{3,020}	26'11"{8.22}
-10'{-3.0m}	lb{kg}	*23,630{10,710}	*23,630{10,710}	*34,780{15,770}	28,950{13,130}	*24,180{10,960}	14,990{6,790}	16,130{7,310}	9,970{4,520}			12,250{5,550}	7,750{3,510}	24'3"{7.39}
-15'{-4.6m}	lb{kg}	*35,300{16,010}	*35,300{16,010}	*27,680{12,550}	*27,680{12,550}	*19,790{8,970}	15,390{6,980}					*13,730{6,220}	10,360{4,690}	19'11"{6.08}

Brand: Ryan's Equipment
Type: Fixed/Rotating Grapple Saw (Bar)
Models: 2059/2070/2078

Ryan's Equipment	2059	2070	2078
Weight (lbs)	1500	2500	3900
Pressure (psi)	3500-4000	3500-4000	3000-4000
Capacity (gpm)	25-45	25-45	25-40
Grapple Opening (in)	59	70	78
Cut Width (in)	20	28	35
Carrier Size (mt)	8-12	12-20	21-26
Rotation (°)	360	360	360
Cost ($)			

Used Ryan's Equipment 2078 Grapple Saw Demo



May 8,9,10,11

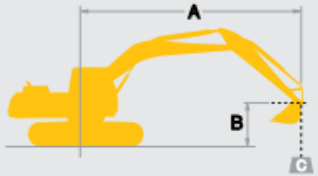
9072 Towpath Rd NE, Bolivar, OH 44612

LONG REACH ATTACHMENT

SK210LC
SK210LC-9

SK260LC
SK260LC-9

Lifting Capacities



Rating over front

Rating over side or 360 degrees

A – Reach from swing centerline for bucket hook
B – Bucket hook height above/below ground
C – Lifting capacities in pounds

SK210LC 50ft Boom; 28'8", Arm; 20'10", Bucket; 06cu.yd. SAE heaped 820 lbs, Counterweight; 12,800 lbs, Shoe; 31.5"

A / B		5'		10'		15'		20'		25'		30'		35'		40'		45'		At Max. Reach		
																						Radius
40'	lb																			* 1,630	* 1,630	33'10"
35'	lb													* 3,000	* 3,000					* 1,460	* 1,460	38'3"
30'	lb													* 3,860	* 3,860	* 2,350	* 2,350			* 1,360	* 1,360	41'7"
25'	lb													* 4,440	* 4,440	* 3,420	* 3,420			* 1,320	* 1,320	44'2"
20'	lb													* 4,830	* 4,830	* 4,180	3,910	* 2,060	* 2,060	* 1,320	* 1,320	46'0"
15'	lb											* 5,750	* 5,750	* 5,220	4,930	* 4,830	3,740	* 2,940	2,820	* 1,350	* 1,350	47'2"
10'	lb			* 20,820	* 20,820	* 12,740	* 12740	* 9,390	* 9,390	* 7,570	* 7,570	* 6,440	6,090	* 5,660	4,810	* 5,110	3,530	* 3,570	2,700	* 1,420	* 1,420	47'11"
5'	lb			* 5,270	* 5,270	* 16,000	15,510	* 11,170	10,380	* 8,650	7,470	* 7,130	5,600	* 6,120	4,290	* 5,410	3,320	* 4,010	2,560	* 1,530	* 1,530	48'0"
GL	lb			* 5,010	* 5,010	* 12,620	* 12,620	* 12,550	9,330	* 9,560	6,810	* 7,740	5,160	* 6,530	3,990	5,450	3,120	* 4,180	2,440	* 1,680	* 1,680	47'8"
-5'	lb	* 4,390	* 4,390	* 6,370	* 6,370	* 11,700	* 11700	* 13,380	8,650	* 10,200	6,320	* 8,200	4,810	6,530	3,750	5,280	2,960	* 3,840	2,350	* 1,900	* 1,900	46'9"
-10'	lb	* 6,280	* 6,280	* 8,190	* 8,190	* 12,750	12,660	* 13,670	8,290	10,460	6,010	7,990	4,580	6,350	3,580	5,170	2,850	* 2,560	2,300	* 2,210	* 2,210	45'3"
-15'	lb	* 8,250	* 8,250	* 10,300	* 10,300	* 14,760	12,660	* 13,460	8,170	10,310	5,870	7,870	4,460	6,260	3,500	5,130	2,810			* 2,670	2,500	43'1"
-20'	lb	* 10,360	* 10,360	* 12,730	* 12,730	* 16,890	12,870	* 12,750	8,230	* 10,030	5,870	7,860	4,460	6,280	3,510	* 3,860	2,880			* 3,370	2,860	40'3"
-25'	lb	* 12,690	* 12,690	* 15,590	* 15,590	* 14,920	13,270	* 11,470	8,450	* 9,080	6,020	* 7,270	4,580	* 5,690	3,660					* 4,580	3,470	36'6"
-30'	lb			* 16,130	* 16,130	* 12,030	* 12,030	* 9,410	8,850	* 7,410	6,330	* 5,640	4,880							* 5,090	4,580	31'6"
-35'	lb					* 7,700	* 7,700	* 6,020	* 6,020											* 4,460	* 4,460	24'5"

SK260LC 60ft Boom; 33'11", Arm; 27'1", Bucket; 05cu.yd. SAE heaped 770 lbs, Counterweight; 15,400 lbs, Shoe; 31.5"

A / B		5'		10'		15'		20'		25'		30'		35'		40'		45'		50'		55'		At Max. Reach		
																										Radius
40'	lb																	* 1,600	* 1,600					* 1,370	* 1,370	45'8"
35'	lb																	* 2,540	* 2,540					* 1,320	* 1,320	49'0"
30'	lb																	* 3,020	* 3,020	* 1,940	* 1,940			* 1,300	* 1,300	51'7"
25'	lb																	* 3,160	* 3,160	* 2,660	* 2,660			* 1,310	* 1,310	53'8"
20'	lb															* 3,500	* 3,500	* 3,370	* 3,370	* 3,250	* 3,250	* 1,450	* 1,450	* 1,350	* 1,350	55'2"
15'	lb													* 4,180	* 4,180	* 3,870	* 3,870	* 3,640	* 3,640	* 3,460	3,330	* 2,040	* 2,040	* 1,420	* 1,420	56'3"
10'	lb											* 5,430	* 5,430	* 4,770	* 4,770	* 4,290	* 4,290	* 3,940	* 3,940	* 3,690	3,140	* 2,460	2,450	* 1,520	* 1,520	56'9"
5'	lb			* 7,370	* 7,370	* 14,570	* 14,570	* 10,040	* 10,040	* 7,700	* 7,700	* 6,300	* 6,300	* 5,380	* 5,380	* 4,740	4,680	* 4,270	3,710	* 3,920	2,950	* 2,740	2,320	* 1,650	* 1,650	56'11"
GL	lb	* 3,070	* 3,070	* 5,660	* 5,660	* 12,570	* 12,570	* 11,850	* 11,850	* 8,900	* 8,900	* 7,130	6,920	* 5,980	5,430	* 5,170	4,320	* 4,590	3,450	* 4,160	2,760	* 2,840	2,190	* 1,820	* 1,820	56'7"
-5'	lb	* 4,450	* 4,450	* 6,270	* 6,270	* 10,720	* 10,720	* 13,180	11,030	* 9,880	8,170	* 7,850	6,320	* 6,510	5,000	* 5,580	4,000	* 4,900	3,220	* 4,380	2,600	* 2,650	2,090	* 2,040	2,020	55'10"
-10'	lb	* 5,810	* 5,810	* 7,400	* 7,400	* 10,910	* 10,910	* 14,030	10,330	* 10,600	7,600	* 8,420	5,870	* 6,950	4,660	* 5,920	3,750	* 5,150	3,040	4,520	2,470			* 2,340	2,050	54'7"
-15'	lb	* 7,200	* 7,200	* 8,750	* 8,750	* 11,890	* 11,890	* 14,470	9,970	* 11,040	7,250	* 8,810	5,580	* 7,280	4,420	* 6,170	3,570	5,250	2,910	4,440	2,390			* 2,750	2,150	52'10"
-20'	lb	* 8,630	* 8,630	* 10,260	* 10,260	* 13,310	* 13,310	* 14,540	9,870	* 11,230	7,100	* 9,010	5,420	* 7,450	4,290	6,180	3,470	5,180	2,840	* 3,930	2,360			* 3,320	2,330	50'6"
-25'	lb	* 10,120	* 10,120	* 11,910	* 11,910	* 15,070	* 15,070	* 14,270	9,950	* 11,140	7,100	* 9,000	5,390	* 7,450	4,260	6,170	3,450	5,190	2,850					* 4,180	2,610	47'7"
-30'	lb	* 11,690	* 11,690	* 13,720	* 13,720	* 17,180	16,130	* 13,620	10,200	* 10,740	7,240	* 8,720	5,490	* 7,220	4,330	* 6,030	3,530							* 5,230	3,080	43'11"
-35'	lb	* 13,330	* 13,330	* 15,690	* 15,690	* 16,460	* 16,460	* 12,540	10,600	* 9,960	7,520	* 8,100	5,790	* 6,660	4,530									* 5,610	3,840	39'3"
-40'	lb			* 17,810	* 17,810	* 14,040	* 14,040	* 10,840	* 10,840	* 8,650	7,970	* 6,970	6,080											* 6,050	5,280	33'2"
-45'	lb																							* 6,550	* 6,550	24'7"

Standing Timber Weight and Pole Length Thresholds

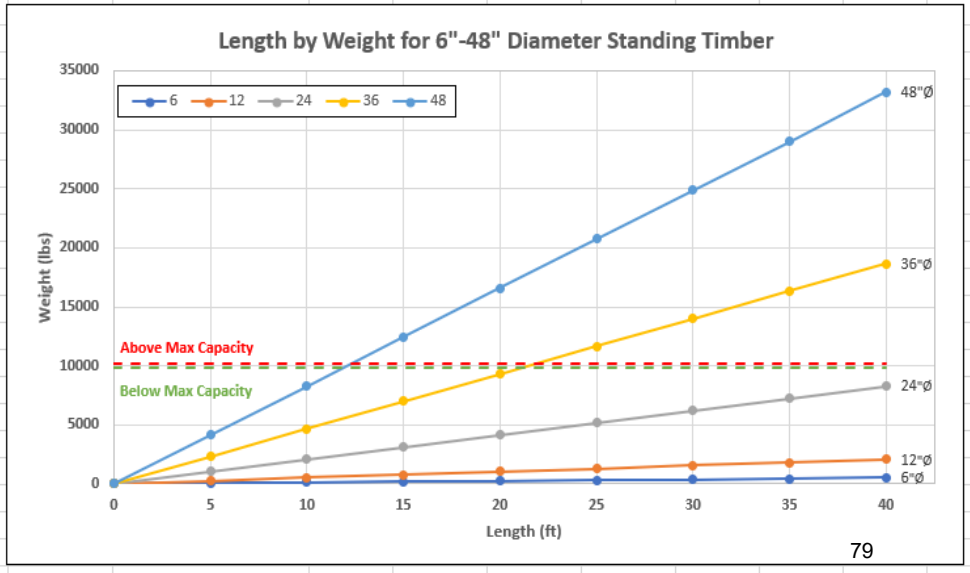
Species	Density (lbs/cu.ft.)
Ash, Green	47
Ash, White	48
Basswood	42
Beech	54
Birch, Yellow	57
Butternut	46
Cherry, Black	45
Chestnut	55
Cottonwood	49
Elm, American	54
Fir, Douglas	39
Fir, White	47
Gum, Black	45
Hackberry	50
Hemlock, Eastern	49
Hickory, Shagbark	64
Honeylocust	63
Locust, Black	58
Maple, Red	50
Maple, Silver	45
Maple, Sugar	56
Oak, Black	62
Oak, Pin	64
Oak, Scarlet	64
Oak, White	62
Osage Orange	62
Persimmon	63
Pine, Loblolly	53
Poplar, Yellow	38
Sassafras	44
Sweetgum	55
Sycamore	52
Walnut, Black	58
Willow	32
Unknown	66

Source: Green Log Weight Chart

WEIGHT	
66	Density (lbs/cu.ft.)
24	Diameter (inches)
20	Length (ft)
4147	Weight (lbs)

MAX LENGTH	
66	Density (lbs/cu.ft.)
24	Diameter (inches)
8000	Max Weight (lbs)
38.6	Max Length (ft)

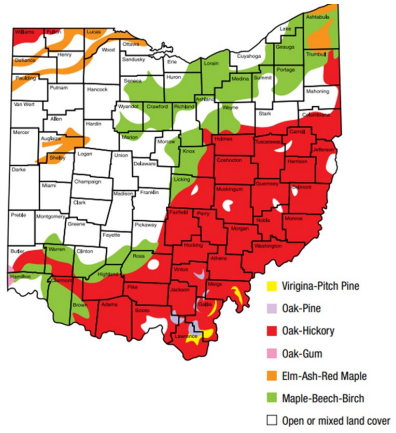
66	Density (lbs/cu.ft.)
10000	Machine Capacity (lbs)



Log Weight Calculation

OHIO DIVISION OF WILDLIFE

TREES OF OHIO field guide
DIVISION OF WILDLIFE



Green Log Weight Chart

Diameters from 14 inches to 49 inches

larger sizes continued on back

Courtesy of Mark Adams, Certified Arborist and Certified Treecare Safety Professional (CTSP)

TCIA
VOICE OF TREE CARE
TREE CARE INDUSTRY ASSOCIATION
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Londonderry, NH 03053
Phone (603) 314-5380
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E-mail: info@tcia.org
www.tcia.org

Species	Dia. in inches → Weight per cubic foot ↓	14	16	18	20	22	24	26	28	30	32	34	36	37	38	39	40	41	42	43	44	45	46	47	48	49
		Weight in Pounds, of One Foot Section																								
Alder, red	46	49	64	81	100	121	145	170	197	226	257	290	325	343	362	382	401	422	443	464	486	508	531	554	578	602
Apple	55	59	77	97	120	145	173	203	235	270	307	347	389	411	433	456	480	504	529	555	581	607	635	663	691	720
Ash, green	47	50	66	83	103	124	148	173	201	231	262	296	332	351	370	390	410	431	452	474	496	519	542	566	591	615
Ash, Oregon	48	51	67	85	105	127	151	177	205	236	268	303	339	358	378	398	419	440	462	484	507	530	554	578	603	629
Ash, white	48	51	67	85	105	127	151	177	205	236	268	303	339	358	378	398	419	440	462	484	507	530	554	578	603	629
Aspen, quaking	43	46	60	76	94	114	135	159	184	211	240	271	304	321	339	357	375	394	414	434	454	475	496	518	540	563
Baldcypress	51	55	71	90	111	135	160	188	218	250	285	322	360	381	402	423	445	468	491	514	539	563	589	614	641	668
Basswood	42	45	59	74	92	111	132	155	180	206	235	265	297	314	331	348	367	385	404	424	443	464	485	506	528	550
Beech	54	58	75	95	118	143	170	199	231	265	302	340	382	403	425	448	471	495	520	545	570	596	623	651	679	707
Birch, paper	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Birch, yellow	57	61	80	101	124	150	179	210	244	280	318	359	403	426	449	473	497	523	548	575	602	630	658	687	716	746
Butternut	46	49	64	81	100	121	145	170	197	226	257	290	325	343	362	382	401	422	443	464	486	508	531	554	578	602
Cedar, incense	45	48	63	80	98	119	141	166	192	221	251	284	318	336	354	373	393	413	433	454	475	497	519	542	565	589
Cedar, western red	26	30	39	49	61	74	88	103	120	137	156	177	198	209	221	232	244	257	269	282	296	309	323	337	352	367
Cherry, black	45	48	63	80	98	119	141	166	192	221	251	284	318	336	354	373	393	413	433	454	475	497	519	542	565	589
Chestnut	55	59	77	97	120	145	173	203	235	270	307	347	389	411	433	456	480	504	529	555	581	607	635	663	691	720
Chinaberry	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Cottonwood	49	52	68	87	107	129	154	181	210	241	274	309	346	366	386	406	428	449	471	494	517	541	566	590	616	642
Elm, American	54	58	75	95	118	143	170	199	231	265	302	340	382	403	425	448	471	495	520	545	570	596	623	651	679	707
Fir, Douglas	39	42	54	69	85	103	123	144	167	191	218	246	276	291	307	324	340	358	375	393	412	431	450	470	490	511
Fir, noble	29	31	40	51	63	77	91	107	124	142	162	183	205	217	228	241	253	266	279	292	306	320	335	349	364	380
Fir, white	47	50	66	83	103	124	148	173	201	231	262	296	332	351	370	390	410	431	452	474	496	519	542	566	591	615
Gum, black	45	48	63	80	98	119	141	166	192	221	251	284	318	336	354	373	393	413	433	454	475	497	519	542	565	589
Gum, red	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Hackberry	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Hemlock, eastern	49	52	68	87	107	129	154	181	210	241	274	309	346	366	386	406	428	449	471	494	517	541	566	590	616	642
Hemlock, western	41	44	57	72	89	108	129	151	175	201	229	259	290	306	323	340	358	376	394	413	433	453	473	494	515	537
Hickory, Shagbark	64	68	89	113	140	169	201	236	274	314	357	404	452	478	504	531	559	587	616	645	676	707	739	771	804	838
Honeylocust	63	67	88	111	137	166	198	232	269	309	352	397	445	470	496	523	550	578	606	635	665	696	727	759	792	825
Horsechestnut	41	44	57	72	89	108	129	151	175	201	229	259	290	306	323	340	358	376	394	413	433	453	473	494	515	537
Larch	51	55	71	90	111	135	160	188	218	250	285	322	360	381	402	423	445	468	491	514	539	563	589	614	641	668
Locust, black	58	62	81	102	127	153	182	214	248	285	324	366	410	433	457	481	506	532	558	585	612	641	669	699	729	760
Locust, honey	61	65	85	108	133	161	192	225	261	299	341	385	431	456	480	506	532	559	587	615	644	674	704	735	767	799
Magnolia, ev.	59	63	82	104	129	156	185	218	252	290	330	372	417	441	465	489	515	541	568	595	623	652	681	711	741	773
Maple, red	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Maple, silver	45	48	63	80	98	119	141	166	192	221	251	284	318	336	354	373	393	413	433	454	475	497	519	542	565	589
Maple, sugar	56	60	78	99	122	148	176	206	239	275	313	353	396	418	441	465	489	513	539	565	591	619	646	675	704	733
Oak, black	62	66	87	110	135	164	195	229	265	304	346	391	438	463	488	514	541	568	597	625	655	685	716	747	779	812
Oak, Cali. black	66	71	92	117	144	174	207	243	282	324	369	416	467	493	520	548	576	605	635	666	697	729	762	796	829	864
Oak, English	52	56	73	92	113	137	163	192	222	255	290	328	368	388	410	431	454	477	500	524	549	574	600	627	653	681
Oak, live	76	81	106	134	166	201	239	280	325	373	424	479	537	567	599	630	663	697	731	766	803	839	877	916	955	995
Oak, pin	64	68	89	113	140	169	201	236	274	314	357	404	452	478	504	531	559	587	616	645	676	707	739	771	804	838
Oak, post	63	67	88	111	137	166	198	232	269	309	352	397	445	470	496	523	550	578	606	635	665	696	727	759	792	825
Oak, red	63	67	88	111	137	166	198	232	269	309	352	397	445	470	496	523	550	578	606	635	665	696	727	759	792	825
Oak, scarlet	64	68	89	113	140	169	201	236	274	314	357	404	452	478	504	531	559	587	616	645	676	707	738	771	804	838
Oak, white	62	66	87	110	135	164	195	229	265	304	346	391	438	463	488	514	541	568	597	625	655	685	716	747	779	812
Osage orange	62	66	87	110	135	164	195	229	265	304	346	391	438	463	488	514	541	568	597	625	655	685	716	747	779	812
Pecan	61	65	85	108	133	161	192	225	261	299	341	385	431	455	480	506	532	559	587	615	644	674	704	735	767	799
Persimmon	63	67	88	111	137	166	198	232	269	309	352	397	445	470	496	523	550	578	606	635	665	696	727	759	792	825
Pine, loblolly	53	57	74	94	116	140	167	195	227	260	296	334	375	396	417	440	463	486	510	534	560	585	612	639	666	694
Pine, lodgepole	39	42	54	69	85	103	123	144	167	191	218	246	276	291	307	324	340	358	375	393	412	431	450	470	490	511
Pine, longleaf	55	59	77	97	120	145	173	203	235	270	307	347	389	411	433	456	480	504	529	555	581	607	635	663	691	720
Pine, ponderosa	46	49	64	81	100	121	145	170	197	226	257	290	325	343	362	382	401	422	443	464	486	508	531	554	578	602
Pine, slash	58	62	81	102	127	153	182	214	248	285	324	366	410	433	457	481	506	532	558	585	612	641	669	699	729	760
Pine, sugar	52	56	73	92	113	137	163	192	222	255	290	328	368	388	410	431	454	477	500	524	549	574	600	627	653	681
Pine, white	36	38	50	64	79	95	113	133	154	177	201	227	254	269	284	299	314	330	346	363	380	398	415	434	452	471
Poplar, yellow	38	41	53	67	83	100	119	140	162	187	212	240	269	284	299	315	332	348	366	383	401	420	439	458	478	498
Redwood, coastal	50	53	70	88	109	132	157	184	214	245	279	315	353	373	394	415	436	458	481	504	528	552	577	602	628	655
Sassafras	44	47	61	78	96	116	138	162	188	216	246	277	311	329	347	365	384	403	423	444	465	486	508	530	553	576
Spruce, Red	34	36	47	60	74	90	107	125	145	167	190	214	240	254	268	282	297	312	327	343	359	376	392	410	427	445
Spruce, sitka	32	34	45	57	70	84	101	118	137	157	179	202	226	239	252	265	279	293	308	323	338	353	369	386	402	419
Sweetgum	55	59	77	97	120	145	173	203	235	270	307	347	389	411	433	456	480	504	529	555	581	607	635	663	691	720
Sycamore	52	56	73	92	113	137	163	192	222	255	290	328	368	388	410	431	454	477	500	524	549	574	600	627	653	681
Tamarack	47	50	66	83	103	124	148	173	201	231	262	296	332	351	370	390	410	431	452	474	496	519	542	566	591	615
Walnut, black	58	62	81	102	127	153	182	214	248	285	324	366	410	433	457	481	506	532	558	585	612	641	669	699	729	760
Willow	32	34	45	57	70	84	101	118	137	157	179	202	226	239	252	265	279	293	308	323	338	353	369	386	402	419

Statewide Equipment List

340291	0003 6700 - Richland County Garage	3	334 - GRAPPLE, ATTACHMENT	188486-1-1	2022	ROTOBEC	4042HD-B-CQ2-GK4-A
9990779	0007 5400 - Roadway Services	7	999 - UNIVERSAL (FITS ALL EQUIPMENT)	7MW00427	2015	CATERPILLAR	72"

Brand: Rotobec
Type: HD Grapple (Grapple Only)
Models: 4042HD/4048HD/4552HD/6058HD/6065HD

Rotobec	4042HD	4048HD	4552HD	6058HD	6065HD
Weight (lbs)	1385	1510	1730	1930	2715
Pressure (psi)	2500-5000	2500-5000	2500-5000	2500-5000	2500-5000
Capacity (gpm)	15-23	15-23	22-33	22-33	29-41
Grapple (in)	42	48	53	58	66
Cost ($)					

Brand: Rotobec
Type: Grapple Saw (Saw Only)
Models: RGS404/RGS750

Rotobec	RGS404	RGS750
Weight (lbs)	443	670
Pressure (psi)	3500	3150
Capacity (gpm)	42	55
Bar Length (in)	39	45
Cost ($)		

Labor Rates

Ohio Department of Transportation
FY 2023 Earthwork

WORK ORDER SUMMARY

Date:04/25/2023 Page: 1 of 6 Time:1.30 PM

Division / Cost Center: 0011 6700 - Tuscarawas County Garage
Work Order #: 15678081
Activity: M201-001 - Clearing and Grubbing
Sub-Activity 1 - * NO SUBACTIVITY
Accomplishment: 192 Units: Labor Hrs Estimate:
Start Date: 03/06/2023 End Date: 03/10/2023
Comments: Sky Trim

Inv. Element	NLF ID	County	Route	Starting MP	Ending MP	Portion Work	Date
	STUSIR00077**C	Tuscarawas	IR00077	5.50	6.14	1.0	03/06/2023
	STUSIR00077**C	Tuscarawas	IR00077	6.14	6.58	1.0	03/07/2023
	STUSIR00077**C	Tuscarawas	IR00077	6.58	6.98	1.0	03/08/2023
	STUSIR00077**C	Tuscarawas	IR00077	6.98	6.98	1.0	03/09/2023

Labor:

Employee Name	Employee ID	Work Date	TRC	Hours	Direct Labor Cost	Total Cost
PRICE, JEREMY	10120516	03/06/2023	REG - REGLR Regular Pay	8	$ 206.8800	$ 587.5392
ERICKSON, RICKEY	10152201	03/06/2023	REG - REGLR Regular Pay	8	$ 203.5200	$ 577.9968
GROVE, SCOTT	10165720	03/06/2023	REG - REGLR Regular Pay	8	$ 193.6000	$ 549.8240
PIRAINO, SCOTT	10145837	03/06/2023	REG - REGLR Regular Pay	8	$ 188.8800	$ 536.4192
WARREN, JASON	10181020	03/06/2023	REG - REGLR Regular Pay	8	$ 176.0000	$ 499.8400
GRASSELLI, DAVID	10203433	03/06/2023	REG - REGLR Regular Pay	10	$ 202.0000	$ 614.0800
STUBER, MICHAEL	10117895	03/06/2023	REG - REGLR Regular Pay	1	$ 40.5200	$ 132.0952
WAGGONER, TOBY	10143429	03/06/2023	REG - REGLR Regular Pay	4	$ 114.0000	$ 323.7600
RENICKER, JERRY	10143530	03/06/2023	REG - REGLR Regular Pay	10	$ 255.4000	$ 776.4160
HAGAN, MICAH	10068260	03/06/2023	REG - REGLR Regular Pay	2	$ 87.3000	$ 247.9320
FINCHER, GABRIEL	10015949	03/06/2023	REG - REGLR Regular Pay	10	$ 268.0000	$ 814.7200
ANDERSON, NATHAN	10196860	03/06/2023	REG - REGLR Regular Pay	7.5	$ 151.1250	$ 429.1950
RENICKER, JERRY	10143530	03/07/2023	REG - REGLR Regular Pay	10	$ 255.4000	$ 776.4160
STUBER, MICHAEL	10117895	03/07/2023	REG - REGLR Regular Pay	2	$ 81.0400	$ 264.1904
GRASSELLI, DAVID	10203433	03/07/2023	REG - REGLR Regular Pay	10	$ 202.0000	$ 614.0800
FINCHER, GABRIEL	10015949	03/07/2023	REG - REGLR Regular Pay	10	$ 268.0000	$ 814.7200
WAGGONER, TOBY	10143429	03/07/2023	REG - REGLR Regular Pay	2	$ 57.0000	$ 161.8800
HAGAN, MICAH	10068260	03/07/2023	REG - REGLR Regular Pay	3	$ 130.9500	$ 371.8980
PIRAINO, SCOTT	10145837	03/07/2023	REG - REGLR Regular Pay	8	$ 188.8800	$ 536.4192
DINGER, GARRET	10208034	03/07/2023	REG - REGLR Regular Pay	8	$ 157.0400	$ 445.9936

Equipment Rates

Ohio Department of Transportation
Office of Equipment Management
1620 West Broad Street
Columbus, OH 43223

2023 Equipment Standard Rates

Effective January 1, 2023 through December 31, 2023

Equipment:

Equipment ID	Equipment Class	License Plate	Work Date	Total Hrs	Mileage	Direct Equipment Cost	Total Cost
	OVER (DO NOT USE)						
2340186	234 - STAKE, 1 1/2 & OVER, W/LIFTGATE	T11839	03/07/2023	8	57	$ 163.0200	$ 179.3220
2546156	254 - DUMP TRUCK, S&I, SINGLE AXLE, GVWR > 26000 LB	T11932	03/07/2023	8	81	$ 328.8600	$ 361.7460
2546206	254 - DUMP TRUCK, S&I, SINGLE AXLE, GVWR > 26000 LB	T11937	03/07/2023	8	13	$ 52.7800	$ 58.0580
2720313	272 - TRAILER, OVER 10 TON	804T11	03/07/2023	8	0	$ 0.0000	$ 0.0000
3140677	314 - ARROW BOARD PORTABLE		03/07/2023	8	74	$ 102.1200	$ 112.3320
3200426	320 - BROOM, TOWED & PUSHED TYPE		03/07/2023	8	0	$ 0.0000	$ 0.0000
3220188	322 - ATTENUATOR,TRUCK MOUNTED		03/07/2023	8	0	$ 0.0000	$ 0.0000
3400191	340 - CHIPPER, BRUSH		03/07/2023	8	5	$ 87.5000	$ 96.2500
3420006	342 - ALL TERRAIN TREE TRIMMER		03/07/2023	8	6	$ 542.7600	$ 597.0360
4710080	471 - EXCAVATOR, TRACKED, OPERATING WEIGHT > 38000 LBS		03/07/2023	8	7	$ 536.6900	$ 590.3590
5910133	591 - LOADER, SKID STEER		03/07/2023	8	4	$ 82.9600	$ 91.2560
2130650	213 - UTILITY TRUCK 3/4 TON AND OVER (DO NOT USE)	T11599	03/08/2023	10	67	$ 57.6200	$ 63.3820
2130609	213 - UTILITY TRUCK 3/4 TON AND OVER (DO NOT USE)	T11554	03/08/2023	8	52	$ 44.7200	$ 49.1920
2218567	221 - PICKUP, 1/2 TON	T11534	03/08/2023	2	45	$ 27.4500	$ 30.1950
2330294	233 - STAKE, 1 1/2 & OVER, STANDARD	T11799	03/08/2023	8	61	$ 120.1700	$ 132.1870
2340186	234 - STAKE, 1 1/2 & OVER, W/LIFTGATE	T11839	03/08/2023	8	66	$ 188.7600	$ 207.6360
2533215	253 - DUMP TRUCK, GVWR <= 26000 LB	T11596	03/08/2023	8	43	$ 52.0300	$ 57.2330
2546156	254 - DUMP TRUCK, S&I, SINGLE AXLE, GVWR > 26000 LB	T11932	03/08/2023	8	41	$ 166.4600	$ 183.1060
3140677	314 - ARROW BOARD PORTABLE		03/08/2023	8	0	$ 0.0000	$ 0.0000
3200426	320 - BROOM, TOWED & PUSHED TYPE		03/08/2023	8	41	$ 117.2600	$ 128.9860

340 - CHIPPER, BRUSH $- $38.21
342 - ALL TERRAIN TREE TRIMMER $- $17.50
469 - EXCAVATOR, TRACKED, OPERATING WEIGHT < 20,000 LBS $- $43.13
470 - EXCAVATOR, TRACKED, OPERATING WEIGHT > 20,001 LBS & < 37,999 LBS $-$49.37
471 - EXCAVATOR, TRACKED, OPERATING WEIGHT > 38,000 LBS $- $76.67
591 - LOADER, SKID STEER $- $20.74

Current Process

5 X  $50-$75 (~7-hours per day)

2-6 X  $50-$75 (~7-hours per day)

Cut Poles
$100-$450

Grind Stumps
$75

Trim
$75

Clear
$75

Chip
$75-$150

Remove Poles
$21

New Process #1

6 X  $50-$75 (~7-hours per day)

$75

$75

$75-$150

Cut Poles

$75?

$21

$75

Additional Operator

New Process #2

5 X  $50-$75 (~7-hours per day)

$75

$75?

$75-$150

$21

$75

Parameter Estimates

- Number of Personnel
  - Reasonable Range to Estimate
- Efficiency
  - Time Increase/Decrease ???
  - Reasonable Range to Estimate
- Equipment Costs
  - Reasonable Range to Estimate
- Operating Days per Year
  - Reasonable Range to Estimate
- Safety
  - Reduced Exposure/Injury
  - Qualitative
- Work Conditions
  - Worker Satisfaction
  - Qualitative

MODEL	SK210LC or CX210
HP	160
DIG DEPTH	22'
DAY	$773
WK.	$2,319
MO.	$6,957

ADD TO QUOTE

MODEL	SK230SR or CX245D SR
HP	160
DIG DEPTH	21' 7"
DAY	$816
WK.	$2,448
MO.	$7,344

ADD TO QUOTE

MODEL	SK260LC or CX250
HP	177
DIG DEPTH	23'
DAY	$910
WK.	$2,730
MO.	$8,190

ADD TO QUOTE

MODEL	SK300 or CX300
HP	220
DIG DEPTH	23' 4"
DAY	$995
WK.	$2,985
MO.	$8,955

ADD TO QUOTE

MODEL	SK350LC or CX350
HP	270
DIG DEPTH	24' 10"
DAY	$1,037
WK.	$3,111
MO.	$9,333

ADD TO QUOTE

MODEL	SK260LR or CX250D LR
HP	177
DIG DEPTH	47' 9"
DAY	$1,447
WK.	$4,341
MO.	$13,023

ADD TO QUOTE

MODEL	SK390LC
HP	270
DIG DEPTH	23' 1"
DAY	$1,265
WK.	$3,795
MO.	$11,385

ADD TO QUOTE

MODEL	SK500LC or CX490
HP	350
DIG DEPTH	25' 7"
DAY	$1,573
WK.	$4,719
MO.	$14,157

ADD TO QUOTE

Appendix E

District Highway Maintenance ROC - Task 8

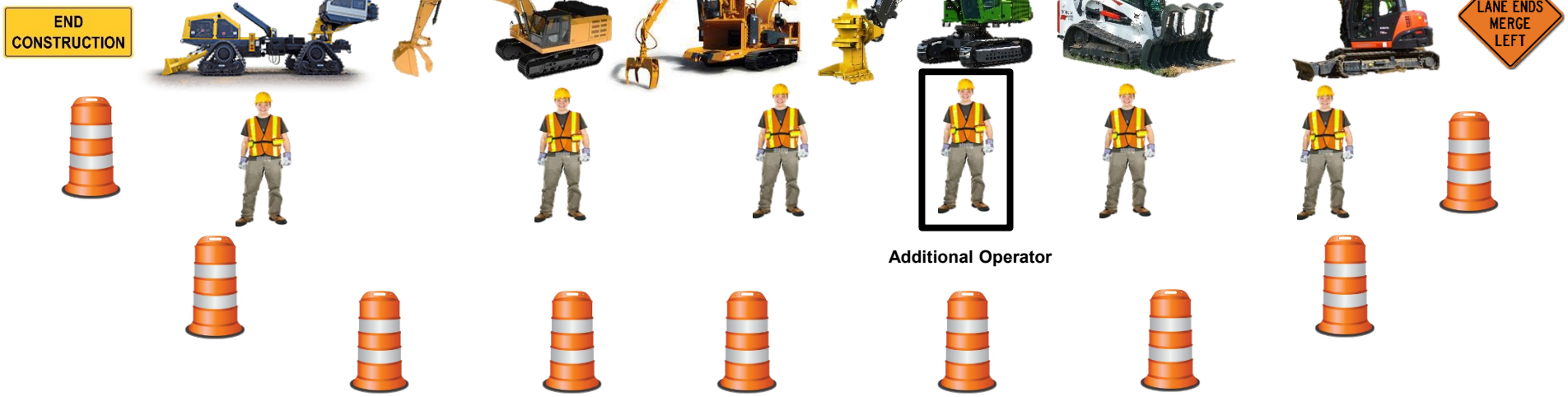
Outline

- Cost Analysis
- Evaluation of the impacts of new process on improving the safety of ODOT employees

New Process

- Efficiency
- Time Increase/Decrease
- Safety Reduced Exposure/Injury
- Work Conditions

$19-24 (~7-hours per day)



COST ANALYSIS-IR 77

- For each work order we separated the administrator(s) from the total number of workers for each working day.
- The labor cost without administrator(s) was computed for current and new method.

Day	Total Without Admin (Current)	Total Without Admin (New)
1	10	6
2	10	6
3	9	6
4	10	6
Total	39	24

COST ANALYSIS-IR 77

	Labor Cost	Equipment Cost	Total Cost
Current Process	$ 22,369.58	$9,815.50	$32,185.07
New Process	$ 14,252.06	$12,455.50	$26,707.56
Saving Per Day	$2,029.38	($660.00)	$1,369.38

Number of Days per Year	30	45	60
Saving Per Year	$41,081	$61,622	$82,163
Equipment Cost	$285,000	$285,000	$285,000
Years to Pay Equipment	6.9	4.6	3.5

COST ANALYSIS-US 22-DEC.22

	Total Without Admin (Current)	Total Without Admin (New)
Total	66	30

	Labor Cost	Equipment Cost	Total Cost
Current Process	$ 44,997.88	$11,646.71	$56,644.59
New Process	$ 21,293.16	$14,946.71	$36,239.88
Saving Per Day	$5,926.18	($825.00)	$4,080.94

Number of Days per Year	30	45	60
Saving Per Year	$122,428.29	$183,642.44	$244,856.59
Equipment Cost	$285,000	$285,000	$285,000
Years to Pay Equipment	2.3	1.6	1.2

COST ANALYSIS-US 22-JAN.23

	Total Without Admin (Current)	Total Without Admin (New)
Total	121	54

	Labor Cost	Equipment Cost	Total Cost
Current Process	$79,106.35	$24,047.85	$ 103,154.20
New Process	$37,133.35	$29,987.85	$67,121.20
Saving Per Day	$4,663.67	($660.00)	$4,003.67

Number of Days per Year	30	45	60
Saving Per Year	$120,109.99	$180,164.99	$240,219.99
Equipment Cost	$285,000.00	$285,000.00	$285,000.00
Years to Pay Equipment	2.4	1.6	1.2

SAFETY IMPACT EVALUATION

- District obtained from the safety department the tree removal related injuries during the past few years.

Injury Date	Injury Nature	Action
26-May-20	Head	Flying Debris in Eye
16-Feb-22	Leg	Employee struck by limb in lower leg
23-Jan-20	Leg	Right Leg contusion while cutting brush
12-Mar-20	Leg	Stepped in hole while cutting tree
05-Nov-20	Back	Lifting brush into chipper hurt back
07-Feb-23	Head	Employee while loading the chipper, limb struck employee in face

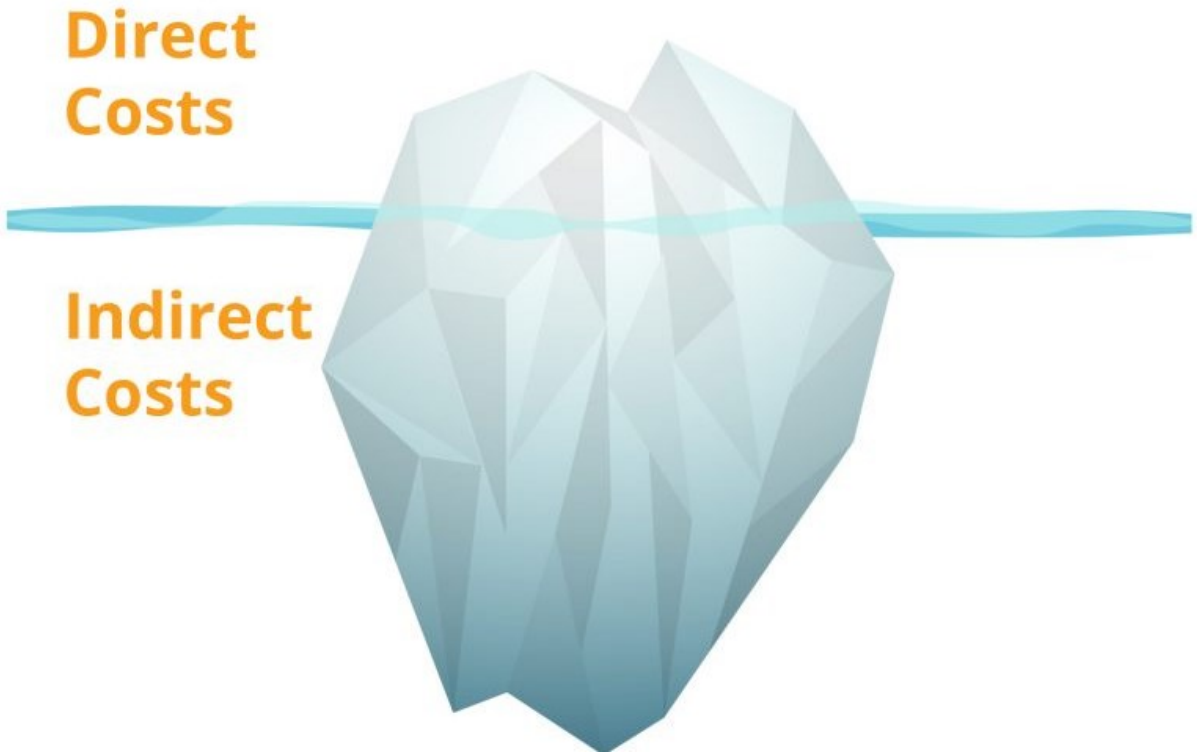
SAFETY IMPACT EVALUATION

- We searched different sources to obtain the estimated cost for workers injury.
- OSHA's Safety Pays Program has a website to assess the impact of occupational injuries and illnesses on their profitability **https://www.osha.gov/safetypays/estimator**

Injury Type	Direct Cost	Indirect Cost
Fracture	$54,856	$60,341
Concussion	$54,571	$60,028
Dislocation	$75,190	$82,709
Sprain	$30,487	$33,535

*The extent to which the employer pays the direct costs depends on the nature of the employer's workers' compensation insurance policy. ***The employer always pays the indirect costs.***

SAFETY IMPACT EVALUATION



SAFETY IMPACT EVALUATION

- Wages lost during disruptions caused by an injury.
- Disruptions occur during time spent on assessing the injured workers and working conditions at the time of the accident.
- Recovery of lost productivity, that is, hiring and training temporary workers, diminished productivity and quality, overtime costs, and more
- Additional human resources such as medical advisors, legal counsel, third-party consultants, and others
- Administrative time spent by staff: HR, safety personnel, and supervisors to complete documentation, coordinate return to work and investigation reporting

Questions?

Appendix F

Excavator Summary Report

ODOT Research-On-Call Task #8

Submitted: June 5, 2023

Submitted by: Jon Witter

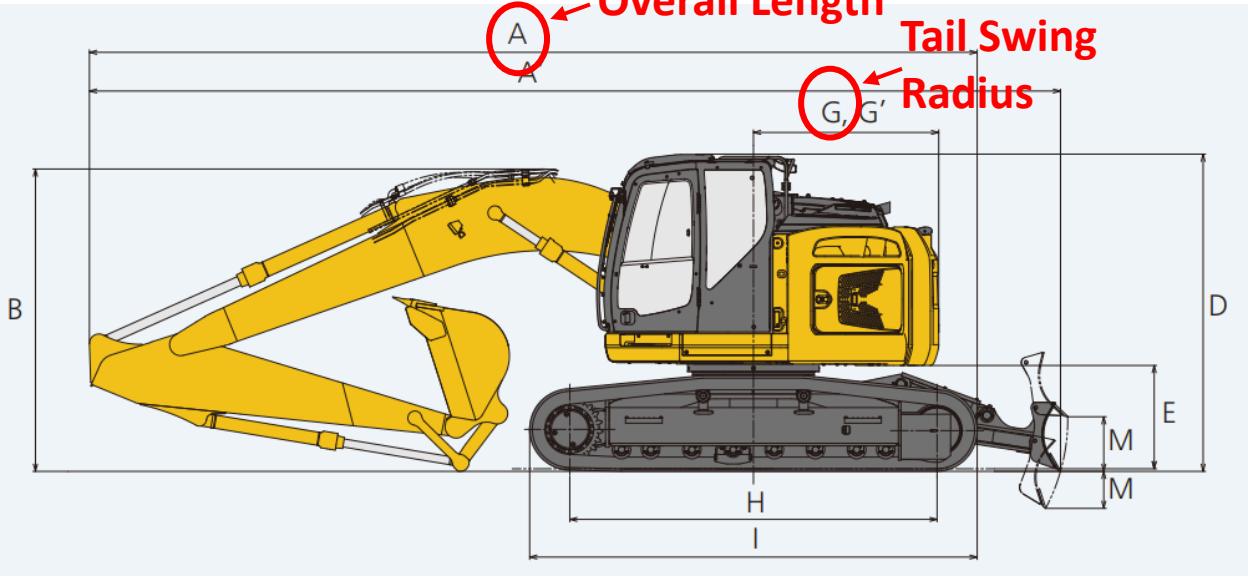
Sourcewell Discounts

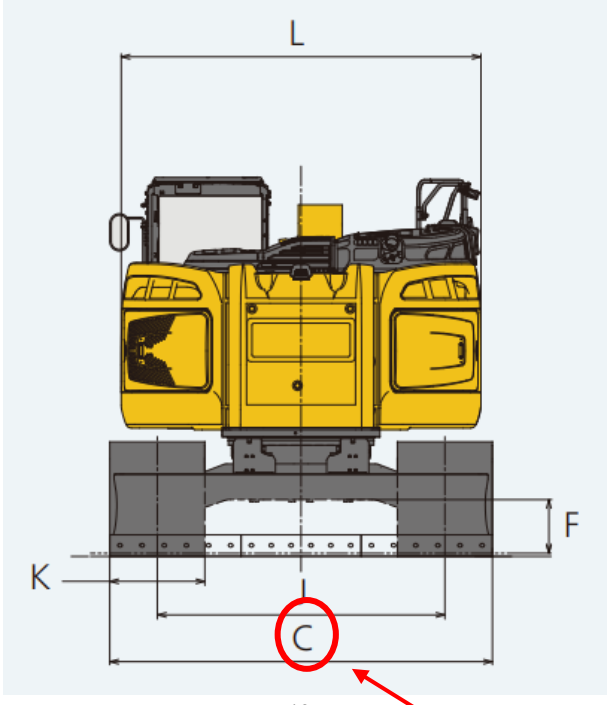
Brand	Discount	Contract Number	Contract Period
Case	26.0%	032119-CNH	5/13/2024
Caterpillar	10.0-20.0%	032119-CAT	5/13/2024
Doosan	30.0%	040319-CEC	5/31/2024
Gradall	4.00%	040319-GRD	5/31/2024
Gradall	NA	011723-GRD	4/14/2027
Hitachi	19%	011723-HTI	4/14/2027
Hyundai	51.0%	032119-HCE	5/13/2024
Hyundai	51.0%	011723-HCE	4/14/2027
John Deere	30.0-43.0%	011723-JDC	4/14/2027
Kobelco	30.0%	011723-KBL	4/15/2027
Komatsu	33-55%	032119-KOM	5/13/2024
Kubota	24.0%	040319-KBA	5/31/2024
Link-Belt	NA	011723-LIN	4/13/2027
Volvo	36.9-41.4%	032119-VCE	5/13/2024

Local Dealerships

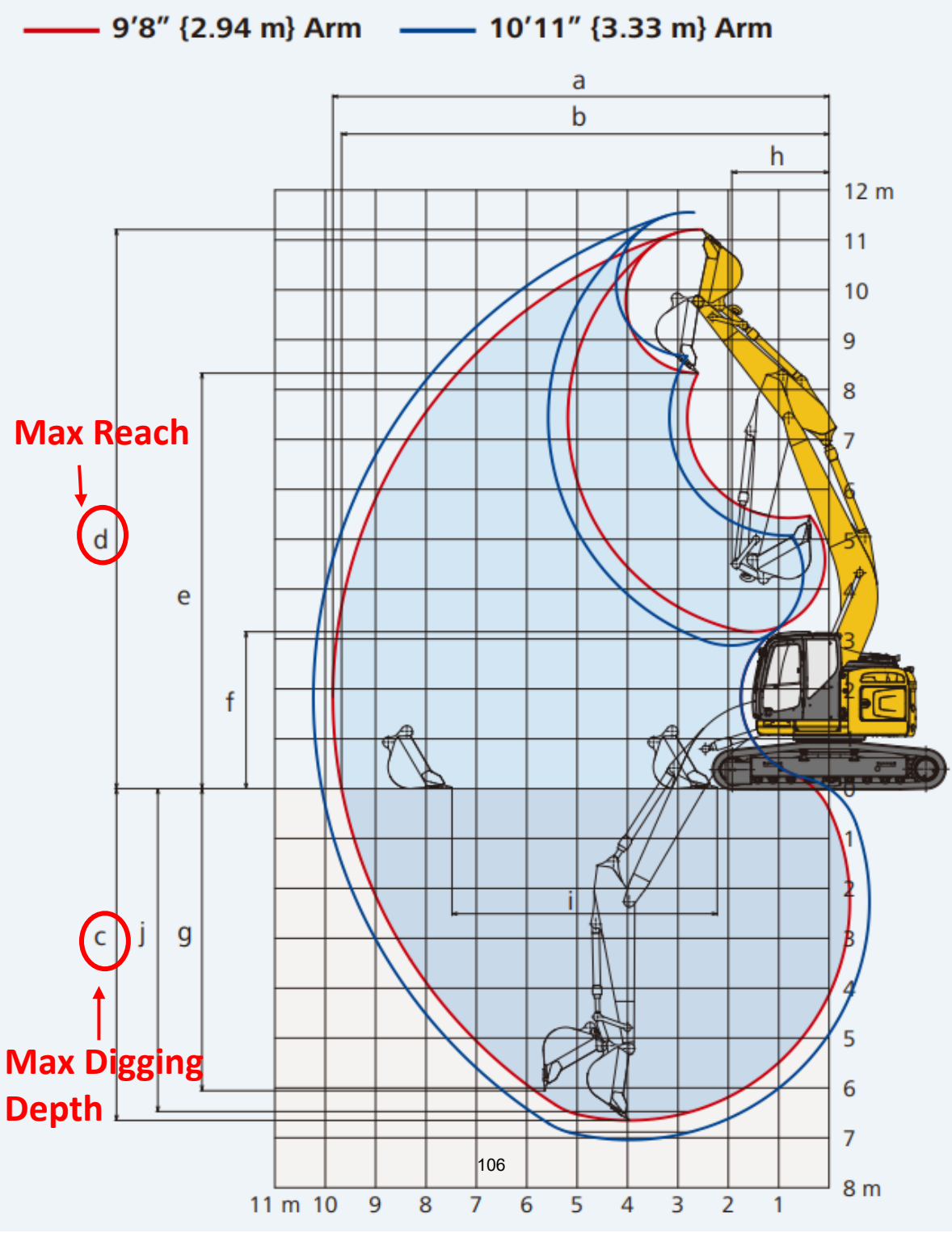
Brand	Local Dealer	Address	Contact
Case	Southeastern Equipment Co.	10874 East Pike Road, Cambridge, OH 43725	740-432-6303
Caterpillar	Ohio CAT	10955 Industrial Parkway NW, Bolivar, OH 44612-8991	330-874-1003
Develon Doosan	Alta Construction Equipment	181 Oak Leaf Oval, Bedford, OH 44146	440-439-4000
Gradall	Southeastern Equipment Co.	10874 East Pike Road, Cambridge, OH 43725	740-432-6303
Hitachi	RECO Equipment	41245 Reco Drive Belmont, OH 43718	740-782-1314
Hyundai	Highway Equipment	1405 Timken Drive SW Canton, OH 44706	330-915-8391
John Deere	Murphy Tractor & Equipment	60611 Hulse Rd Cambridge, OH 43725	740-439-2747
Kobelco	Southeastern Equipment Co.	10874 East Pike Road, Cambridge, OH 43725	740-432-6303
Komatsu	Columbus Equipment Company	290 Old Steubenville Road, Cadiz, OH 43907	740-942-8871
Kubota	Lashley Tractor Sales	24821 Lashley Road Quaker City, OH 43773	740-679-2141
Link-Belt	Columbus Equipment Company	290 Old Steubenville Road, Cadiz, OH 43907	740-942-8871
Volvo	Rudd Equipment Company	2451 Enterprise Parkway Twinsburg, OH 44087	216-393-7833

Excavator Dimensions





Working Ranges



Caterpillar Excavators

	320	323	325	326	330	335
Weight (lbs)	49,600	56,200	62,800	65,400	69,200	79,900
Power (hp)	172	172	172	201	273	273
Length (ft' in")	32’1”	32’1”	30’1”	33’0”	34’2”	32’5”
Width(ft' in")	10’5”	10’5”	10’5”	11’1”	11’1”	11’9”
Tail Swing (ft' in")	9’3”	9’4”	5’11”	9’10”	10’3”	6’3”
Max Dig Depth (ft'in")	22’0”	25’2””	22’0”	24’6”	25’7”	24’9”
Max reach (ft’ in”)	37’10”	37’10”	38’4”	32’8”	33’6”	37’5”
Notes	Mono and 2-piece booms	Mono and 2-piece booms 2 Arm Sizes	Short Radius Mono and 2-piece booms	2 Arm Sizes	2 Arm Sizes	2 Arm Sizes

Develon (Doosan) Excavators

	DX225LC-7	DX225LC-7X	DX235LCR-7	DX255LC-7	DX300LC-7
Weight (lbs)	52,690	52,768	58,930	59,563	69,446
Power (hp)	162	162	170	185	267
Length (ft' in")	31’6”	31’6”	29’5”	33’2”	34’10”
Width(ft' in")	10’9”	10’6”	10’6”	11’5”	11’2”
Tail Swing (ft' in")	9’7”	9’7”	5’8”	10’0”	10’7”
Max Dig Depth (ft'in")	23’6”	23’6”	21’11”	23’11”	24’0”
Max reach (ft’ in”)	31’8”	31’8”	35’5”	32’2”	33’10”
Notes	2 Arm Sizes	Technology Upgrade 2 Arm Sizes	Short Radius	2 Arm Sizes	

Hitachi Excavators

	ZX210LC-6	ZX245USLC-7	ZX250LC-6	ZX300LC-6
Weight (lbs)	50,265	58,202	59,525	67,902
Power (hp)	164	164	177	249
Length (ft' in")	31’8”	28’11”	34’2”	35’2”
Width(ft' in")	10’6”	10’6”	11’1”	11’1”
Tail Swing (ft' in")	9’6”	5’6”	10’4”	10’6”
Max Dig Depth (ft'in")	21’11”	21’8”	25’0”	25’10”
Max reach (ft’ in”)	32’11”	36’10”	34’8”	34’4”
Notes	-6 and -7 versions	Short Radius	-6 and -7 versions	

Hyundai Excavators

	HX210A L	HX220A L	HX235A LCR	HX260A L	HX300A L
Weight (lbs)	51,080	54,516	54,140	61,530	73,061
Power (hp)	170	170	170	227	255
Length (ft' in")	31’8”	31’8”	29’4”	33’4”	35’3”
Width(ft' in")	10’10”	10’10”	10’6”	11’5”	11’5”
Tail Swing (ft' in")	9’4”	9’5”	6’4”	10’1”	10’5”
Max Dig Depth (ft'in")	25’0”	25’4”	21’11”	24’10”	25’4”
Max reach (ft’ in”)	33’10”	33’2”	35’6”	33’9”	34’2”
Notes	4 Arm Sizes	4 Arm Sizes	Short Radius 3 Arm Sizes	4 Arm Sizes	4 Arm Sizes

John Deere Excavators

	200G	210P	245P	250P	300P
Weight (lbs)	45,170	53,483	56,879	60,600	68,674
Power (hp)	146	159	159	188	223
Length (ft' in")	29’8”	31’8”	29’11”	34’2”	35’2”
Width(ft' in")	9’10”	10’6”	10’6”	11’1”	11’1”
Tail Swing (ft' in")	8’4”	9’6”	5’6”	10’4”	10’8”
Max Dig Depth (ft'in")	23’2”	21’11”	21’8”	25’0”	25’10”
Max reach (ft’ in”)	32’1”	32’11”	36’8”	34’8”	34’4”
Notes	2 Arm Sizes		Short Radius	2 Arm Sizes	2 Arm Sizes

Kobelco Excavators

	SK210LC	SK230SRLC	SK260LC	SK270SRLC	SK300LC
Weight (lbs)	58,400	57,100	62,600	61,100	69,200
Power (hp)	160	164	194	164	265
Length (ft' in")	31’9”	29’0”	33’6”	29’8”	35’4”
Width(ft' in")	10’5”	10’5”	11’1”	11’1”	11’1”
Tail Swing (ft' in")	9’7”	6’0”	10’2”	6’2”	10’10”
Max Dig Depth (ft' in")	23’10”	21’7”	25’2”	23’1”	26’7”
Max reach (ft’ in”)	32’0”	34’9”	33’6”	37’11”	34’3”
Notes	2 Arm Sizes	Short radius	High and Wide 2 Arm Sizes	Short radius 2 Arm Sizes	2 Arm Sizes

Komatsu Excavators

	PC210LC(i)	PC238USLC	PC240LC	PC290LC(i)
Weight (lbs)	53,882	55,660	56,360	72,091
Power (hp)	165	165	177	196
Length (ft' in")	31’10”	29’3”	32’9”	33’8”
Width(ft' in")	10’1”	10’5”	10’9”	11’1”
Tail Swing (ft' in")	9’11”	5’11”	9’11”	9’11”
Max Dig Depth (ft'in")	21’9”	21’9”	24’0”	23’4”
Max reach (ft’ in”)	32’9”	35’1”	33’10”	33’11”
Notes	Intelligent version	Short Radius	2 Arm Sizes	2 Arm Sizes Intelligent version

Link-Belt Excavators

	210 X4 (HD)	220 X4S	245 X4 Spin Ace	250 X4 (HD)	260 X4S	300 X4(S)
Weight (lbs)	48,900	48,900	56,900	56,900	57,300	67,700
Power (hp)	160	160	160	177	177	253
Length (ft' in")	31’2”	31’1”	29’3”	32’8”	32’10”	34’10”
Width(ft' in")	10’6”	10’6”	10’6”	11’1”	8’6”	11’2”
Tail Swing (ft' in")	9’2”	9’3”	5’10”	9’8”	9’10”	10’10”
Max Dig Depth (ft' in")	21’10”	21’9”	21’10”	24’4”	24’4”	24’10”
Max reach (ft’ in”)	31’6”	31’6””	32’4”	33’0””	33’0”	34’1”
Notes	Heavy Duty Model Option		Short Radius 2 Arm Sizes	3 Arm Sizes Heavy Duty Model Option		3 Arm Sizes HD Model Option

Volvo Excavators

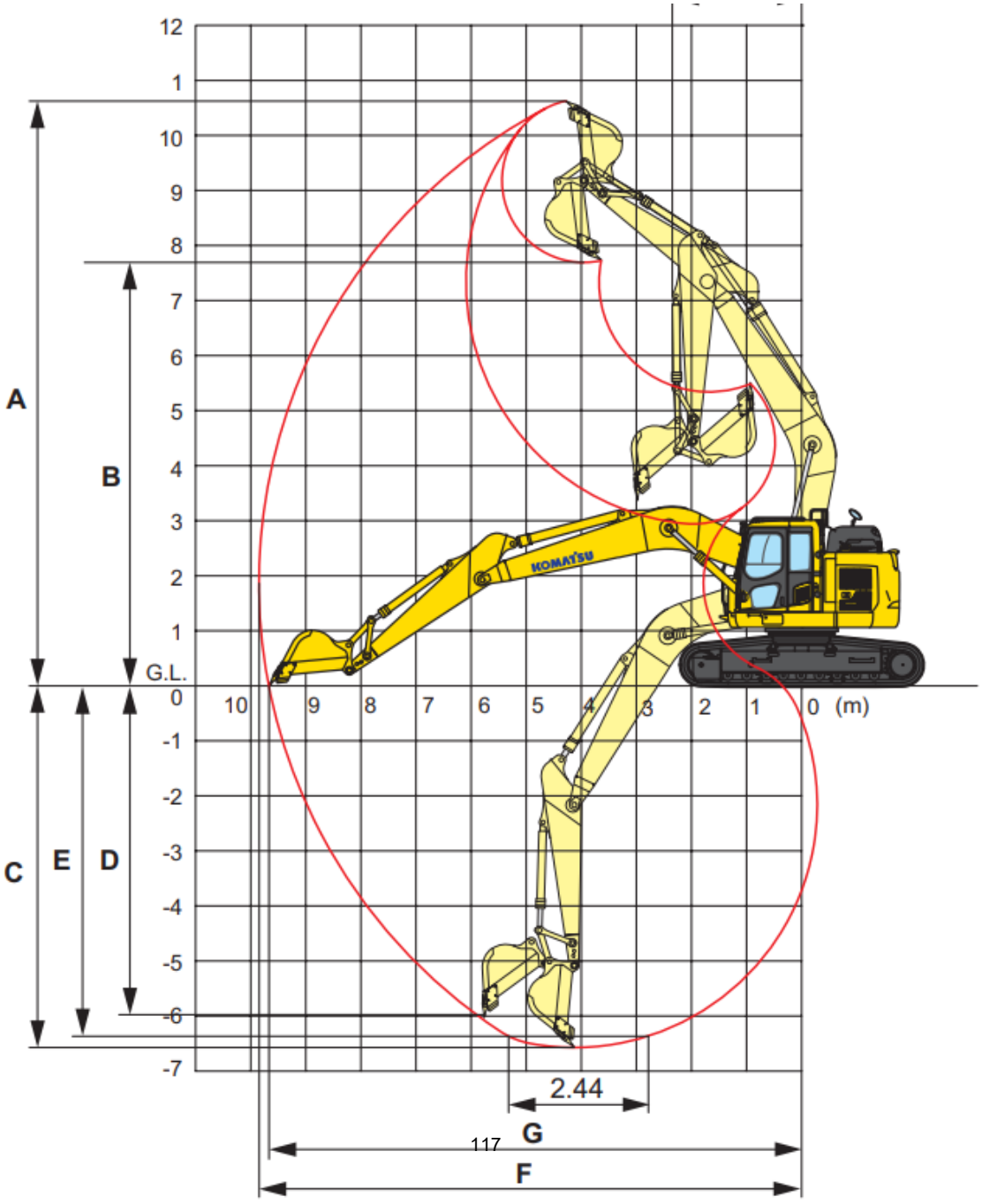
	EC200E	EC220E	ECR235E	EC250E	EC300
Weight (lbs)	54,388	55,360	61,440	69,780	81,230
Power (hp)	154	172	172	224	252
Length (ft' in")	31’9”	32’2”	29’9”	33’10”	34’10”
Width(ft' in")	9’10”	9’10”	10’2”	10’6”	10’6”
Tail Swing (ft' in")	9’4”	9’4”	5’11”	10’1”	10’3”
Max Dig Depth (ft' in")	22’3”	24’1”	22’2”	25’3”	26’3”
Max reach (ft’ in”)	31’2”	35’10”	37’9”	38’2”	41’3”
Notes		4 Arm Sizes Mono and 2-piece boom	Short Radius 3 Arm Sizes Mono and 2-piece boom	Hybrid Option 3 Arm Sizes Mono and 2-piece boom	Hybrid Option

Summary of Short Tail Swing Excavators

	Case CX245D SR	CAT 325	Develon DX235LCR-7	Hitachi ZX245USLC-7	Hyundai HX235A LCR	John Deere 245P
Weight (lbs)	56,900	62,800	58,930	58,202	54,140	56,879
Power (hp)	160	172	170	164	170	159
Length (ft' in")	29’3””	30’1”	29’5”	28’11”	29’4”	29’11”
Width(ft' in")	10’6”	10’5”	10’6”	10’6”	10’6”	10’6”
Tail Swing (ft' in")	6’4”	5’11”	5’8”	5’6”	6’4”	5’6”
Max Dig Depth (ft' in")	21’10”	22’0”	21’11”	21’8”	21’11”	21’8”
Max reach (ft’ in”)	36’1”	38’4”	35’5”	36’10”	35’6”	36’8”
Notes	2 Arm Sizes	Mono and 2-piece booms			3 Arm Sizes	

	Kobelco SK230SRLC	Kobelco SK270SRLC	Komatsu PC238USLC	Link-Belt 245 X4 Spin Ace	Volvo ECR235E
Weight (lbs)	57,100	61,100	55,660	56,900	61,440
Power (hp)	164	164	165	160	172
Length (ft' in")	29’0”	29’8”	29’3”	29’3”	29’9”
Width(ft' in")	10’5”	11’1”	10’5”	10’6”	10’2”
Tail Swing (ft' in")	6’0”	6’2”	5’11”	5’10”	5’11”
Max Dig Depth (ft' in")	21’7”	23’1”	21’9”	21’10”	22’2”
Max reach (ft’ in”)	34’9”	37’11”	35’1”	32’4”	37’9”
Notes		2 Arm Sizes		2 Arm Sizes	3 Arm Sizes Mono and 2-piece boom

Komatsu
PC238USLC



Appendix G

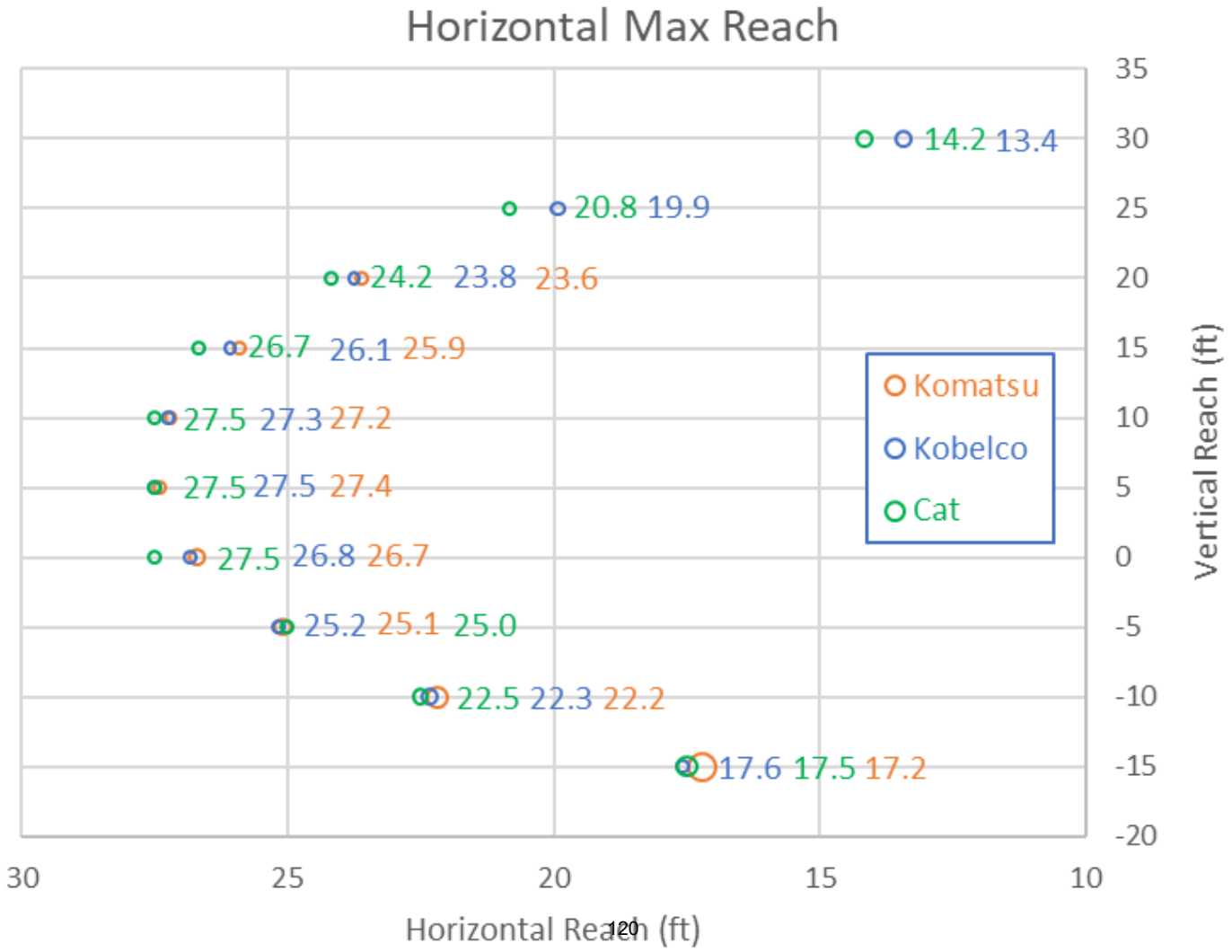
Comparison of Excavator Reach/Lift Excavator and Grapple Saw Quotes

ODOT Research-On-Call Task #8

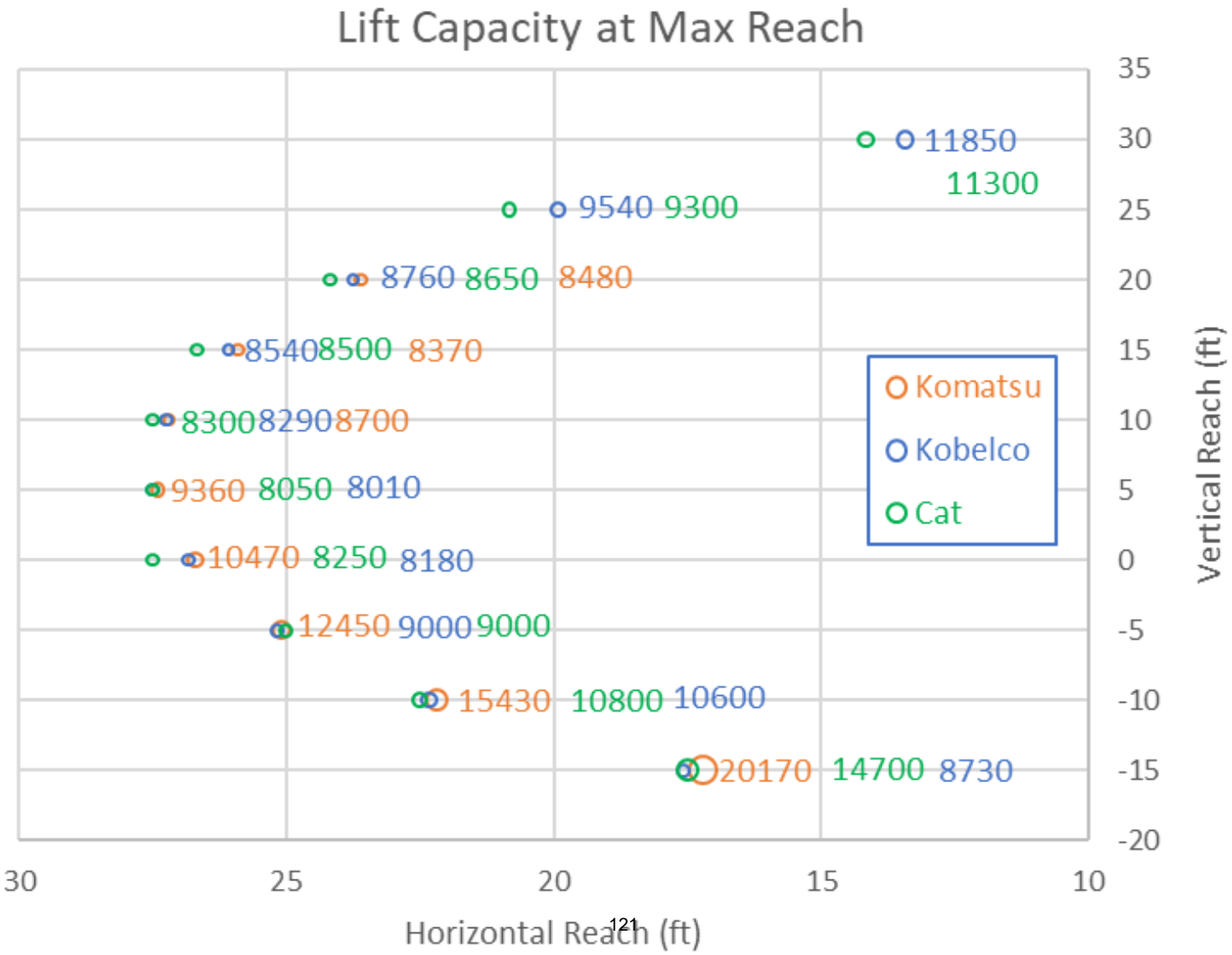
Submitted: June 21, 2023

Submitted by: Jon Witter

Horizontal Reach (Feet) at 5-Foot Increments of Vertical Height



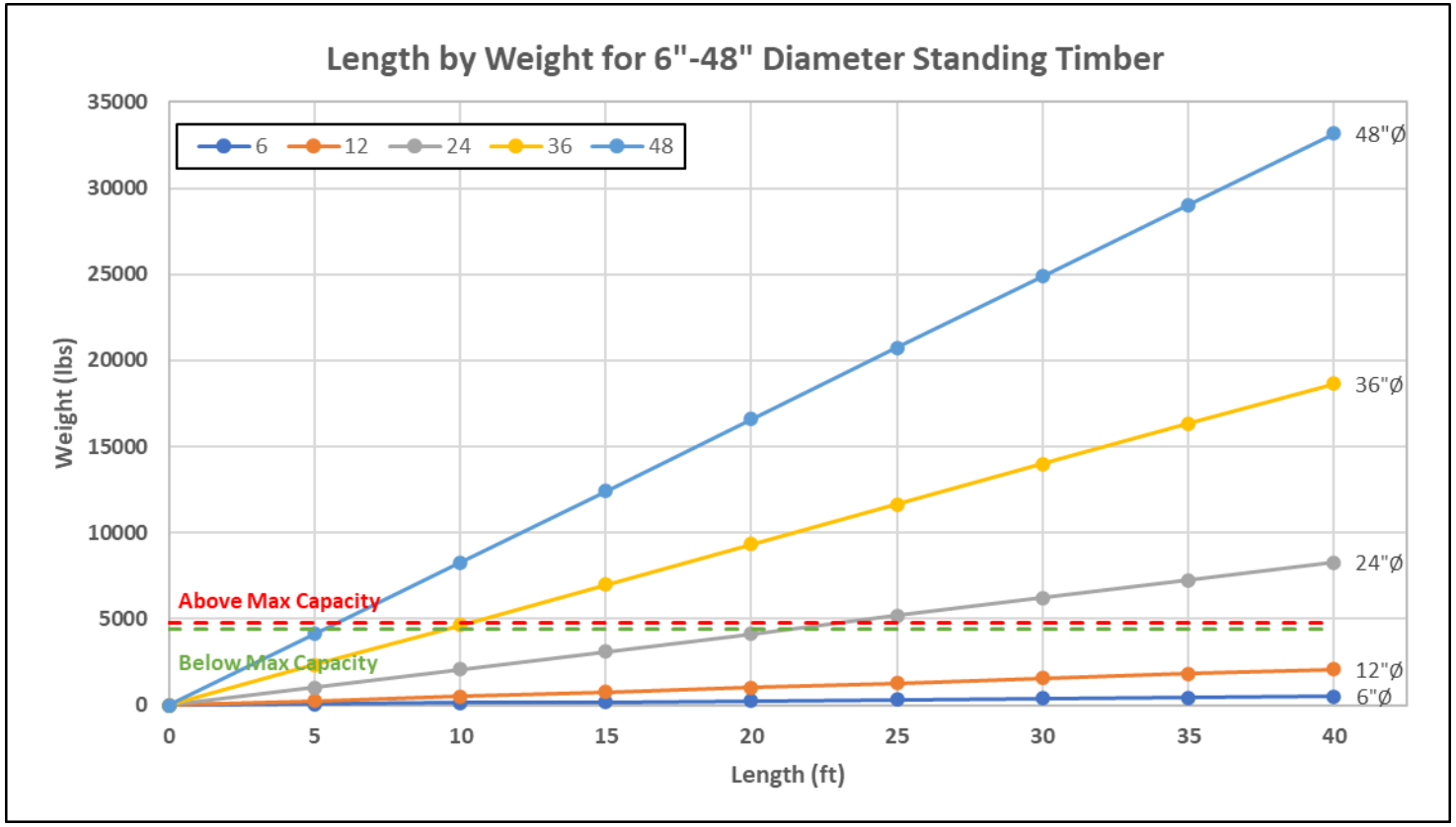
Lift Capacity (In Pounds) at Max Reach



Brand: Ryan's Equipment
Type: Fixed/Rotating Grapple Saw (Bar)
Models: 2059/2070/2078

Ryan's Equipment	2059	2070	2078
Weight (lbs)	1500	2500	3900
Pressure (psi)	3500-4000	3500-4000	3000-4000
Capacity (gpm)	25-45	25-45	25-40
Grapple Opening (in)	59	70	78
Cut Width (in)	20	28	35
Carrier Size (mt)	8-12	12-20	21-26
Rotation (°)	360	360	360
Cost ($)			

Log Lengths for Various Diameter Trees Based on 4600-lbs Lift Capacity



Kobelco SK270SRLC-7

Eq #/ Item #	Product Description	Hours	Product Notes	List Price	Discount %	Sourcewell Total Price
KOBELCO SK270SRLC-7	Base Machine with air conditioned cab, tinted glass, AM/FM radio, travel alarm, 270 degree 3 camera system and top guard.			$268,720.00	30%	$188,104.00
7-53	Air Suspension Heated Seat, included			$0.00	30%	$0.00
2-15	Semi-Triple Grousers 31.5" (800mm) Wide			$4,340.00	30%	$3,038.00
3-01	Standard Boom			$18,980.00	30%	$13,286.00
4-05	Long Arm 10'11" (3.21m)			$13,460.00	30%	$9,422.00
5-14	Combination Rotation and Nibbler and Breaker with proportional hand controls and piping for both circuits to end of arm (2nd Auxiliary circuit to operate low pressure attachments)			$4,250.00	30%	$2,975.00
7-32	Cab Guard Front			$1,825.00	30%	$1,277.50
WERK-BRAU D-LOCK COUPLER	SK270 Hydraulic D-LOCK pin-grabber coupler (includes bucket pins) - INSTALLED			$12,500.00	%	$12,500.00
FREIGHT AND PDI	FREIGHT FROM MANUFACTURER TO SOUTHEASTERN EQUIPMENT, PREDELIVERY INSPECTION, FILL WITH FUEL, PREP MACHINE FOR DELIVERY			$5,000.00	%	$5,000.00
					Total Sourcewell Price	$235,602.50

Komatsu PC238USLC-11

PC238USLC-11
31.5" Tripler grouser tracks
18'8" HD Boom with +1 Hydraulics
9'6" arm assembly with +1 Hydraulics
Proportional Joysticks
5,000 hour Extended Power train Warranty

Sourcewell price= $236,629 FOB Wooster Ohio Includes 3 year,

CAT 325

Verbal Quote $300,000+
Includes automated digging and geofencing standard

Waiting for approval on Sourcewell pricing.

Ryan's Equipment F/R 2078

PART NUMBER	DESCRIPTION	QTY	RATE	AMOUNT
412078-008	78" Fixed Rotating Grapple Saw (2078 Grapple) -78" Max Opening -36" Single Cut Capacity -43" Saw Bar -3/4" Pitch Chain -9 Tooth Sprocket -Chain Oil Res. 3 Gal -Rotator Rated to Machine (20-25 Ton) -45cc Hydraulic Motor -Price Includes Mounts, Hoses and Valves -Price does not include Case Drain (required)	1	59,900.00	59,900.00

-Quoted for a 20-25 ton excavator

-Estimated lead time is 5-7 weeks

-Freight TBD (approximately $650)

SUBTOTAL	59,900.00
TAX	0.00
SHIPPING	650.00
TOTAL	**$60,550.00**

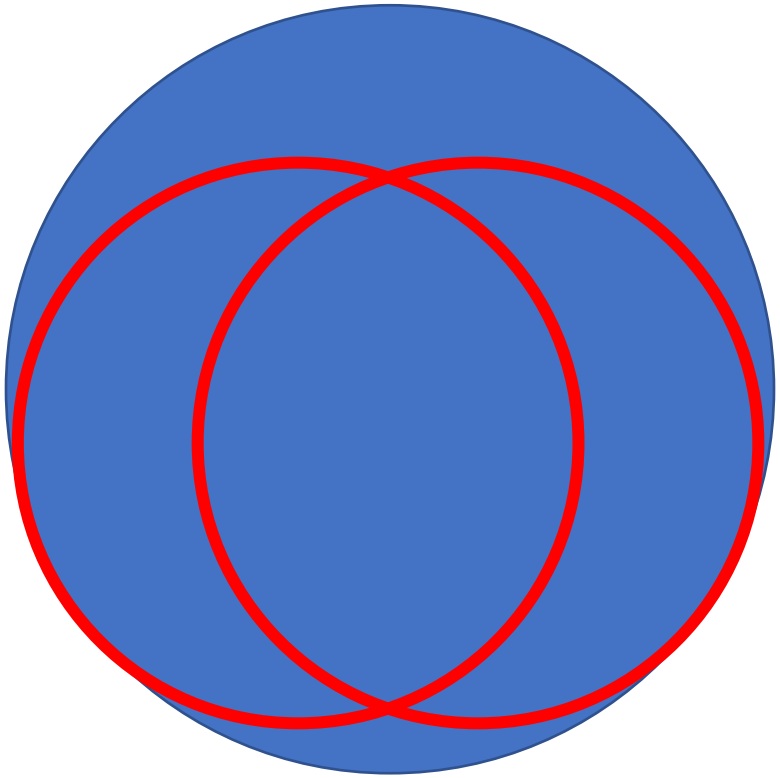
District Survey of Roadside Tree Removal

- District 10 – Joshua Booher
- Number of machines 2
- Days per year in field – >200
  - Canopy trimming to full tree removal
  - Limitations for bat tree removal
  - Year round activity
- Process
  - District provides saw, operator, and self-propelled chipper
  - County has truck, skid steer, chainsaw, labor
  - Specific process varies by county
  - Currently do not use excavator for any part of process
- Safety issues
  - Known injuries related to workers on slopes
- Interested in research findings
- Need other districts

Recommendations

- Appears worthy of next phase RFP
- Scope recommendations
  - Equipment acquisition
    - Determine purchase process
    - Finalize equipment and/or bid process details
    - Equipment transfer, if needed
  - Direct comparison of current vs. new process
  - Evaluation of different removal approaches
    - Less trimming, more grapple?
  - Thorough ROI
  - Safety assessment
  - Manager and worker surveys

4’ Diameter Tree with 35” Cut Width



Appendix H

ODOT ROC Task #8

Survey of Vegetation Removal in Other Districts

District: 10

District Contact: Joshua Booher

1. **Extent or frequency of field work for tree removal.**
    - 2 saws
    - 200+ days per year
        - Canopy trimming
        - Full tree removal
            - Limited to acceptable dates for bat trees

2. **Timing of trimming/removal.**
    - Year round

3. **Process details.**
    - District provides tree saws and operator (2 saws total)
    - District has self-propelled chipper with grapple
    - Equipment provided by county may include:
        - Traffic control
        - Chipper
        - Chainsaws
        - Skid loader with grapple
    - Process varies by county
    - No known use of excavator with grapple saw

4. **Safety issues with current process.**
    - Working on slopes and ice is always a concern
    - Known injuries related to process

5. **Suggestions for process improvements.**
    - Process is unique in each of 9 counties
    - Interested in research findings

ODOT ROC Task #8

Survey of Vegetation Removal in Other Districts

District: 9

District Contact: David Walton

1. **Extent or frequency of field work for tree removal.**
   - Occasional
     - Some inhouse work, most outsourced to Russel Tree Service
     - Labor shortage is major issue for outsourcing

2. **Timing of trimming/removal.**
   - Year round

3. **Process details.**
   - Limited to canopy clearing
     - Tree saw and chipper

4. **Safety issues with current process.**
   - Safety is also a concern with outsourcing

5. **Suggestions for process improvements.**
   - Happy with outsourcing for canopy removal
   - Probably need to do more full tree removal

ODOT ROC Task #8

Survey of Vegetation Removal in Other Districts

District: 5

District Contact: Phil Valentine

6. **Extent or frequency of field work for tree removal.**
   - Multiple crews (typically 3)
     - Various methods include tree saw and bucket trucks

7. **Timing of trimming/removal.**
   - Primarily limited to bat tree season

8. **Process details.**
   - Primary process exactly same as District 11
     - Exception, in heavy understory brush they will make an initial pass with the forestry mulcher to make it easier to pull down cut limbs and trees
     - One county in District has larger excavator
     - Chipper has no grapple, fed by excavator or hand

9. **Safety issues with current process.**
   - Safety is always a concern
   - Several sever injuries historically, but recent emphasis on safety has limited sever injuries
     - Some muscle pulls and joint strains
   - Equipment solution to remove totem poles would be helpful

10. **Suggestions for process improvements.**
    - Fully supportive of this research and believe the findings are on target
      - All counties would agree as they have met multiple times to discuss this issue