Bone and Joint Institute:

The Burden of Bone and Joint Disorders & The Opportunity

Musculoskeletal (MSK) conditions are a leading cause of pain and disability worldwide with tremendous and growing personal and financial costs for patients, families, and society. Western University identified MSK health as a research priority and invested in the Cluster of Research Excellence in MSK Health in 2014 and Bone and Joint Institute (BJI) in 2015. The first term of the BJI was granted to maintain cohesion, growth and excellence in the area of MSK health by establishing a formalized structure that included key MSK stakeholders based in London, ON within its operations and governance. The proposed membership and organizational structure were deemed to be poised to achieve international impact through transdisciplinary research and applied innovation (Appendix A – 2014 Institute Application; Appendix B – 2014 Cluster Application).

BJI’s Overview and Term 1 - 2015 to 2018 Accomplishments

Goal: With a focus on excellence in innovation, collaboration, education and knowledge translation in an area of study with increasing societal importance, the BJI’s goal in the first term was to provide outstanding administrative and logistical services to: 1) promote transdisciplinary collaborative research; 2) deliver research training; 3) support the preparation of applications for major funding; 4) foster outreach, partnerships, globalization and knowledge translation; 5) facilitate internal and external communications; and 6) conduct appropriate performance evaluation (Appendix A).

Through its programs and activities (e.g. catalyst grants program, transdisciplinary training program and awards, research workshops, national networks and events) supported by Institute and Cluster funds, the BJI has created a complex adaptive research environment that brings experts together to mobilize and integrate diverse perspectives, skills and infrastructure. This environment supports the members as they strive to produce high-impact breakthroughs in primary objective areas: 1) understanding bone and joint diseases; 2) innovating in diagnosis and evaluation; 3) developing and evaluating new therapies; and 4) influencing key knowledge users.

Approach: The BJI’s transdisciplinary approach set out to encompass a wide spectrum of research themes that requires experts in: basic biological and biomedical; physical sciences and engineering; clinical health services; and community and population health. This approach was envisioned to advance investigators’ work related to enhancing active living, mobility and movement as well as addressing the causes, prevention, diagnosis, treatment, and support systems for a wide range of MSK conditions (Appendix A). Within the BJI research environment, leaders are encouraged and enabled to generate collaborative transdisciplinary teams that can develop more competitive grant submissions to maximize research impact. The fluidity of the teams, with experts moving from team to team as required (not pillared and static teams), allows the right experts to tackle the right project at the right time with the right group of collaborators for accelerated success and impact.
Transdisciplinary Experts: In the first term, membership grew from 160 to over 260 people from 5 Faculties to achieve an adequate distribution across research themes and primary objectives. Members include: 14 Research Chairs (6 Endowed/Industry-funded), 2 Fellows of the Royal Society of Canada, 3 Fellows of the Canadian Academy of Health Sciences, 1 NSERC Fellow, ~ 10 recipients of Early Career or New Investigator Awards, 3 Distinguished University Professors, and 3 current Faculty Scholars.

BJI recruited Jacqueline Marsh (Health Economics, FHS), Ryan Willing (Orthopaedic Biomechanics, Engineering), and Michele Crites Battié (Western Research Chair [WRC]) in Exercise, Mobility, and Health, FHS). BJI also supported the recruitment of Emil Schemitsch (Richard Ivey Chair of the Department of Surgery, Schulich), Joy MacDermid (Gender in Measurement & Rehab of MSK Work Disability - CIHR and James Roth Research Chair in MSK Measurement & Knowledge Translation, FHS), Tom Appleton (Rheumatologist/Molecular & Cell Biology, Schulich), Emily Lalone (Biomechanics, Engineering), Mikko Karttununen (Materials and Biomaterials Science CRC Tier 1, Science), Andrea Waters-Rist (Bioarcheology, Soc.Sci.), and Jay Stock (Bioarcheology, Soc. Sci.).

Publications (Appendix C): BJI members published 1000 MSK papers in 4 years with the average # of publications per BJI member increasing from 1.9 in 2015 to 3.2 in 2018. Cited by 103 different regions around the world, the average citation impact remained above the world average across all years. Data also suggests that the longer a person is a BJI member, the more their citation area increases.
Research Funding (Appendix E): The BJI Catalyst Grant Program funded 23 early-stage high-impact projects [https://boneandjoint.uwo.ca/research/catalyst_grants_program/index.html]. The awards supported transdisciplinary teams initiating new projects for which external funding would otherwise be difficult to obtain. The funds allowed members to build collaborations that helped advance their work and/or establish a proof of concept. The BJI Catalyst Grants served as stepping-stones to increase leveraging potential for external funds. Since the launch of the BJI, members have pursued funding more aggressively increasing the total # of submissions by nearly 175 applications compared to the previous 4 years. They maintained a greater than 50% success rate across all years despite greater exposure to CIHR compared to the rest of the PI population at Western. Furthermore, mean funding per proposal per PI was higher by an average of $50K for BJI faculty vs non-BJI faculty at Western. BJI members held an average of 3.7 grants/PI compared to 2.4 grants/PI for non-BJI faculty. In 2018, BJI members held 570 grants totaling $110M+ in multi-year funding (90 of which were industry contracts / donations held at Western = 3M+). Since 2015, nearly 60 technology disclosures were submitted by BJI members and a total of 41 patent applications filed. A total of 22 patents were issued between 2015 and 2018. BJI was also crucial to the launch of the medical innovation fellowship program contribution both in-kind and financial support.

Training: Over 50 graduate students completed (76 in progress) the Collaborative Training Specialization in MSK Health Research (CMHR - [https://cmhr.uwo.ca/]) receiving an “in MSK Health Research” degree designation. BJI has awarded transdisciplinary training awards to 55 graduate and 25 undergraduate trainees and over 85 students have engaged in the undergraduate summer program.

In 2018 alone, trainees attracted over 30 external scholarships (e.g. NSERC, CIHR, OGS) totaling over $1.1 M in multi-year funding and published 30+ MSK peer-reviewed articles.

National Engagement & Partnerships:

BJI researchers led the establishment of the Canadian MSK Rehabilitation Research Network in 2016 with a CIHR catalyst grant ($600K) to identify national research priorities, support the development of national platforms, and launch pilot grant and trainee award competitions ([http://mskrehabnet.com/index.html]). A 5-year CIHR network grant ($2M) was awarded in 2019.

A series of meetings were launched by BJI in 2017 (co-funded by CIHR, BJI, and the McCaig Institute) to unify academic leaders, consumers, advocacy groups, decision-makers, and funders across Canada. This resulted in the establishment of the Canadian Network for Mobility Research ([http://boneandjoint.uwo.ca/research/canadian_msk_consortium1.html]), a self-assembled group ready to advance national research priorities and raise Canada’s research profile globally.
BJI hosted various partner events and the Biennial Canadian Bone and Joint Conference (CBJC) to enhance collaboration at the national level (over 300 attendees from around the world in 2018 - http://boneandjoint.uwo.ca/events/cbjc/index.html). The 2018 CBJC was preceded by the first Canadian Bone and Joint Young Investigator Forum (CBJYi), to promote collaboration amongst the next generation of MSK research leaders, experts, and stakeholders (https://cmhr.uwo.ca/Events/Canadian%20Bone%20and%20Joint%20Young%20Investigators%20Forum/index.html).

External Review & Strategic Priorities for 2019-2024

The Institute began its grassroots strategic planning process in the last quarter of 2017. This resulted in a draft public facing strategic plan with relevance and feasibility statements for each strategic objective as well as mechanisms, predictive timelines, and measures of success for each strategic goal (Appendix F). The draft strategic plan, annual reports and other supportive documents were included in the formal review process conducted in 2018. Key reviewer recommendations included: obtaining a stable budget to maintain administrative support; developing a business plan to establish strategies for financially security; engaging additional private sector / community partners on the Board; strengthening relationships with surgical and other MSK-relevant clinical specialties; increasing the recruitment of quality non-Western trainees; and sustaining the award programs.

To finalize the review process, budget projections (2019-2024) were developed with the Vice-President Research (VPR) (Appendix G). Projections included current staff to avoid losing momentum and impact potential. Activities related to sustainable program support, improved marketing and communications with clearer branding, and expanded engagement of private-sector representatives are under way in partnership with Western Leaders. In 2018 (post review), BJI facilitated Research Think Tanks for clinically relevant topics including orthopaedic infections, common spine disorders and wearables for rehabilitation, which have attracted the involvement of multiple clinical leaders (e.g. Dr. Schemitsch - Chief/Chair of Surgery, Dr. Paul - Chief/Chair of Medical Imaging, Dr. Doherty – Chief/Chair of Physical Medicine and Rehabilitation). The organizational chart was revised and the number of clinical advisors on internal committees was expanded. Efforts continue to accommodate schedules/locations as much as possible to facilitate the participation of clinical colleagues (https://boneandjoint.uwo.ca/about_us/governance/index.html).

With respect to training, additional programmatic evaluation was conducted as recommended by the reviewers to assess recruitment sources. This revealed that nearly 50% of CMHR trainees completed their previous degree at a non-Western institution (an average of 18% are international trainees). It also reinforced an opportunity to enhance recruitment of post-doctoral fellows through MSK-focused research societies in addition to ongoing recruitment of top students nationally and internationally. Finally, the transdisciplinary training awards program and the catalyst grants program remain a top priority for sustainability (https://cmhr.uwo.ca/Awards/index.html; https://boneandjoint.uwo.ca/research/catalyst_grants_program/index.html).

Below is a brief overview of updated strategic priorities. Table A provides a visual representation of the linkages between gaps being address by programs and activities, the resources needed, the metrics, and indications of success. The table also includes the BJI’s track record related to specific activities carried out in its first term.
BJI’s overarching goal in the second term is to continue to provide outstanding administrative and logistical services to catalyse transdisciplinary MSK research, innovation, translation and education. Programs and activities will be enhanced or expanded to: 1) maintain the crucial complex inclusive and adaptive research environment (bringing experts together to mobilize and integrate diverse perspectives, skills and infrastructure), and 2) continue to enable high-impact transdisciplinary research to investigate the causes, prevention, diagnosis, treatment for MSK conditions, to enhance movement, mobility and participation in daily life, and to improve support systems and rehabilitation for a wide range of MSK conditions.

**Membership Initiatives and Events to Accelerate Research Success & Innovation**

BJI will continue to maintain a collaborative environment for effective team formation and integration of transdisciplinary perspectives (experts internal and external to Western). It will implement programs and activities that encourage and enable research leaders to develop novel, relevant, and timely research ideas and that support early stage / high risk ideas (independent formation of teams around grassroots ideas and priorities - primarily internal experts).

Fluidity in the teams will remain a priority so that experts can move from team to team as required to allow the right experts to tackle the right project at the right time with the right group of collaborators. BJI will continue to facilitate the mobilization of team members and the development of major grant submissions (e.g. NF, CFI, NIH) to enable high-impact research and publications.

**Gaps to address in the second term** of the BJI with respect to the research environment and research funding include:

- engaging faculty, early career researchers & newly recruited investigators with unique expertise by: 1) working with Faculties, centres and institutes to identify key local stakeholders and experts, and 2) supporting partner Faculties and Western Leadership in the recruitment of top MSK researchers;
- enhancing entrepreneurial culture & skills to advance commercialization and industry contracts potential by partnership with the Pierre L. Morrissette Institute and Western Entrepreneurship to launch an MSK Innovation Program with: 1) entrepreneurship workshop series, 2) a mentorship program for timely research and commercialization advice, and 3) an MSK innovation competition;
• launching a strategic fund to advance BJI strategic research priority initiatives related to the clinical and cost effectiveness studies of: 1) less invasive and joint-preserving treatments, 2) strategies to decrease surgical infection, and 3) tools that support self-management and rehabilitation; and
• enhancing the sharing of data and/or samples and promote the use of standardized research tools/protocols.

**Enhance Education**

The development of the next generation of transdisciplinary MSK researchers remains a high priority for BJI. The Collaborative Training Specialization in MSK Health Research (CMHR) will continue to enhance the home programs of 14 departments in 5 Faculties by offering transdisciplinary training (i.e. courses, seminars, workshops, outreach and internship opportunities, mentorship, etc.) that integrates technology, mechanistic research, and clinical applications. Graduate and undergraduate trainees will have ongoing opportunities to apply for transdisciplinary training awards as part of the collaborative training program and the summer undergraduate program.

**Gaps to address in the second term** of the BJI with respect to the collaborative training program include:

• developing an improved communication plan to increase enrollment of top doctoral students & postdoctoral fellows;
• offering expanded postdoctoral programming to accelerate trainee career progression post-graduation (academic and non-academic sectors) including: 1) expand skill development and career planning workshops (e.g. dossier/CV building), 2) create teaching opportunities and a formal mentorship program , and 3) add MSK-specific content in Western’s Graduate Student Internship Program; and
• increasing trainee’s success rate in external funding competition by launching an internal review process.

**Improve Knowledge Translation**

BJI will continue to support its members by enhancing the interconnectedness of the MSK community locally, regionally, nationally and internationally via its leadership role in the development, implementation and maintenance of lead provincial and national networks and events (e.g. the Canadian Bone and Joint Conference [CBJC] was preceded by the first Canadian Bone and Joint Young Investigator Forum in 2018).

**Gaps to address in the second term** of the BJI with respect to improving knowledge translation include:

• enhancing the collaborative environment among institutions for a coordinated national effort;
• increasing our national and international profile by dedicating resources to: 1) trainee travel awards, 2) showcasing BJI work and accomplishments (e.g. publications, major grants, prestigious awards), and 3) participating in partnered events.
<table>
<thead>
<tr>
<th>Gaps Being Addressed</th>
<th>Programs &amp; Activities</th>
<th>Resources</th>
<th>Indicators / Metrics</th>
<th>Anticipated Outcomes in BJI Second Term/ Indication of Success</th>
</tr>
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<tbody>
<tr>
<td>- engage faculty, early career researchers &amp; newly recruited investigators with unique expertise</td>
<td>- work with Faculties, Centres and Institutes to identify key local stakeholders and experts</td>
<td>40K/yr</td>
<td># of orientation meetings and welcome packages distributed</td>
<td>↑ # of new members by 10%</td>
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<td>- maintain a collaborative environment for effective team formation and integration of transdisciplinary perspectives (experts internal and external to Western)</td>
<td>- support partner Faculties and Western Leadership in the recruitment of top MSK researchers.</td>
<td>Staff time</td>
<td># of MSK researchers recruited</td>
<td>broaden engagement of expertise across multiple Faculties &amp; disciplines with strengths beyond strategic priorities (opportunity to shape future direction of the BJI)</td>
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<td>- support early stage / high risk ideas (independent formation of teams around grassroots ideas and priorities - primarily internal experts)</td>
<td>- develop novel, relevant, and timely research ideas</td>
<td>120K/yr</td>
<td># of events, attendance &amp; distribution of members, # of presenters &amp; topics, # of new collaborative teams / leaders, # of competitions and submissions, % success rate, # of strategic initiatives funded, external funding submissions and amount of external funding awards</td>
<td>host 4 Showcases (for trainees and faculty)/yr, ↑ # of grant submissions by 15%, ↑ per PI funds by 8%, 50% success rate in the catalyst grants program based on peer review process (quality applications) (note: funding success will depend on available funds)</td>
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<tr>
<td>- enhance the sharing of data and/or samples and promote the use of standardized research tools/protocols.</td>
<td>- deliver the catalyst grant program, launch strategic think tanks series and fund for faculty focused on: less invasive and joint-preserving treatments; strategies to decrease surgical infection and tools that support self-management and rehabilitation.</td>
<td>30K/yr</td>
<td># of strategic initiatives funded, external funding submissions and amount of external funding awards, self-report of value-added experience via evaluation forms, surveys, news articles</td>
<td>host Think Tanks Series for 3 strategic areas/yr, at least one submission by BJI members in each appropriate major funding opportunity (e.g. CIHR, CFI, NIH)</td>
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<td>- facilitate the mobilization of team members and the development of major grant submissions (e.g. NF, CFI, NIH) to enable high-impact research and publications.</td>
<td>- host member events (biennial research retreats; showcases / networking series for trainees and faculty)</td>
<td>Staff time</td>
<td># of new collaborative teams / leaders, % success rate, # of strategic initiatives funded, external funding submissions and amount of external funding awards</td>
<td>at least one submission by BJI members in each appropriate major funding opportunity (e.g. CIHR, CFI, NIH)</td>
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<tr>
<td>- Host the Canadian Bone and Joint Conference and Young Investigator Forum</td>
<td>- Annual average of 215 grant submissions across all members in all external competitions with average success rate of 50%</td>
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<td>- Average of 3.7 grants held per PI</td>
<td>- Average of 1 million in total multi-year funding per PI with a total annual multi-year funding peaking at 110 M</td>
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</table>
| • enhance entrepreneurial culture & 
  skills to advance commercialization 
  and industry contracts potential | • partner with the Pierre L. 
  Morrissette Institute and Western 
  Entrepreneurship to launch the: 
  entrepreneurship workshop series; 
  mentorship program for timely 
  research and commercialization 
  advice; and MSK innovations 
  funding competition | • 30K/yr 
  Staff 
  time | • # of tech submissions / disclosures 
  • # of business/industry mentoring 
  relationships 
  • # of industry contracts/donations 
  • self-report of value-add via evaluation 
  forms and surveys | • ↑ tech submissions / disclosures by 
  25% 
  • established a Business/Industry 
  Relations Committee 
  • ↑ business/industry mentorship and 
  contracts | • Disclosed 60 technologies at 
  WorDiscoveries - annual 
  average of 0.13 
  disclosures/PI 
  • 300+ industry 
  contracts/donations totaling 
  7M + |

### Training Program

| • deliver graduate courses and 
  the summer undergraduate 
  program along with learning 
  modules and transdisciplinary 
  mentorship | • offer transdisciplinary training 
  awards to top trainees 
  • improve the communication plan 
  to attract top doctoral students & 
  postdoctoral fellows 
  • enhance skill development and 
  career planning workshops (e.g. 
  dossier/CV building), teaching 
  opportunities, and mentorship for 
  doctoral students & postdoctoral 
  fellows 
  • increase MSK-specific content in 
  Western’s Graduate Student 
  Internship Program 
  • launch an internal review process 
  for external funding proposals | • 265K/yr 
  Staff 
  time | • # of applications and enrollments 
  • # of courses, learning modules, 
  transdisciplinary mentorships, and 
  workshops delivered 
  • # of transdisciplinary training awards 
  submission and success rate 
  • implementation of an updated 
  communications plan 
  • # of formal mentoring relationships 
  • # of teaching opportunities secured by 
  BJI doctoral students & postdoctoral 
  fellows 
  • # of external funding proposals 
  reviewed and success rate 
  • self-report of value-added experiences 
  via evaluation forms, surveys, news 
  articles | • ↑ # of top-rated doctoral students & 
  postdoctoral fellows enrolled in 
  CMHR 
  • 50% success rate in the 
  transdisciplinary awards program 
  based on peer review process (quality 
  applications) (note: funding success 
  will depend on available funds) 
  • ↑ success rate of external training 
  awards to 40% of graduate students 
  • ↑ # of skill development and career 
  planning workshops 
  • ↑ opportunities for trainee-led 
  initiatives (e.g. Young 
  InvestigatorForum, seminars, 
  outreach) | • Novel MSK and leadership 
  programming (50 graduates / 
  76 trainees in progress) 
  • Peak annual enrolment of 
  117 
  • International trainees grew 
  from 11 to 22% in four years 
  and attracted top-rated non- 
  Western trainees (average 
  48% of enrolment) 
  • Graduate employment: 46% 
  academia, 21% private 
  sector, 14% healthcare, 5% 
  public sector |

**Novel MSK and leadership programming (50 graduates / 76 trainees in progress)**
- Peak annual enrolment of 117
- International trainees grew from 11 to 22% in four years and attracted top-rated non-Western trainees (average 48% of enrolment)
- Graduate employment: 46% academia, 21% private sector, 14% healthcare, 5% public sector
### National Initiatives, Dissemination and Communication

- **enhance the interconnectedness of the MSK community locally, regionally, nationally and internationally**
- **enhance the collaborative environment among institutions for a coordinated national effort**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Measurable Outcomes</th>
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</table>
| - lead the development, implementation and maintenance of provincial and national networks and events | - attendance & distribution at BJI events  
- # of national team submissions and % success rate for major funding opportunities  
- # of trainee travel awards and locations  
- self-report of value-added experiences via evaluation forms, surveys, news articles |
| - engage stakeholders with unique expertise across jurisdictions  
- launch trainee travel awards program | - ↑ profile of MSK research at Western and in Canada  
- ↑ participation in BJI led events (e.g. CBJC, CBJYi)  
- ↑ # of trainee travel awards |
| - increase our national and international profile | - Website redesign & maintenance  
- increase stories about BJI initiatives and accomplishments (e.g. publications, major grants, prestigious awards)  
- participate in more partnered events | - ↑ communication to enhance publication exposure and impact (e.g. website, social media, online profile, open-access …)  
- 10% increase in global internet traffic  
- ↑ # of partnered events  
- Maintain a citation impact above world average  
- ↑ # of world regions citing our work |

### Funding and Sustainability

- **increase stable funding / revenue**
- **increase membership fees**
- **maintain central contribution**
- **activate the case for support**
- **increase industry stakeholders**

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<thead>
<tr>
<th>Activities</th>
<th>Measurable Outcomes</th>
</tr>
</thead>
</table>
| - Website redesign & maintenance  
- increase stories about BJI initiatives and accomplishments (e.g. publications, major grants, prestigious awards)  
- participate in more partnered events | - amount of members’ contributions and donations  
- event costs recovery (sponsors)  
- amount of central support  
- # of MOUsa and NDAsb |
| - Website redesign & maintenance  
- increase stories about BJI initiatives and accomplishments (e.g. publications, major grants, prestigious awards)  
- participate in more partnered events | - obtained adequate funding to maintain core BJI operations  
- obtained adequate funding to maintain specialty programing (e.g. trainee awards, catalyst grants, innov. comp.) |

### Operations

- **streamline admin processes (e.g. Dean to sign off procedures)**
- **maintain funds for staff compensation, equipment and supplies**

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<thead>
<tr>
<th>Activities</th>
<th>Measurable Outcomes</th>
</tr>
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</table>
| - change in sign-off procedures (from multiple Deans to VPR)  
- decrease burden and expedite proposals and contracts | - review of admin sign-off policies/procedures |
| - change in sign-off procedures (from multiple Deans to VPR)  
- decrease burden and expedite proposals and contracts | - enough revenue to sustain operations. |

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*a = memorandum of understanding; b = non-disclosure agreements; c = vice-president research; d = delivery versus payment (securities industry settlement method); e = Canadian MSK Rehab Research Network; f = Canadian Bone and Joint Conference; g = Canadian Bone and Joint Young Investigator Forum*
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<th>Appendix A</th>
<th>2014 Institute Application</th>
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<tr>
<td>Appendix B</td>
<td>2014 Cluster Application – need to add to appendix file</td>
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<tr>
<td>Appendix C</td>
<td>Scholarly Impact Report (Western KE/I Team)</td>
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<td>Appendix D</td>
<td>Communications &amp; Public Affairs Report (Terry Rice &amp; Team)</td>
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<td>Appendix E</td>
<td>Funding Report using the ROLA System (David Tweddell)</td>
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<td>Appendix F</td>
<td>BJI Strategic Plan for 2019-2024</td>
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<td>Appendix G</td>
<td>Budget Projections – Fiscal year 2019-2024</td>
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<td>Appendix H</td>
<td>First Term Objectives, Function and Metrics of Success for BJI and Cluster</td>
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